STANDARD &POOR'S

Global Credit Portal
RatingsDirect®

May 19, 2010

Criteria | Insurance | Request for Comment:

A New Level Of Enterprise Risk Management Analysis: Methodology For Assessing Insurers' Economic Capital Models

Primary Credit Analysts:
Laura Santori, Paris (33) 1-4420-7320; laura_santori@standardandpoors.com
Howard L Rosen, New York (1) 212-438-7104; howard_rosen@standardandpoors.com
Miroslav Petkov, London (44) 207-176-7043; miroslav_petkov@standardandpoors.com

Secondary Credit Analysts:
Vladimir Uhmylenko, New York; vladimir_uhmylenko@standardandpoors.com
James Peacock, London (44) 20-7176-7062; james_peacock@standardandpoors.com
Marcus Bowser, London (44) 20-7176-7052; marcus_bowser@standardandpoors.com

Global Insurance:
Mark Puccia, Criteria Officer, New York (1) 212-438-7233; mark_puccia@standardandpoors.com

EMEA Insurance:
Rob Jones, Criteria Officer, London (44) 20-7176-7041; rob_jones@standardandpoors.com

Table Of Contents

Table Of Contents (cont.)

Criteria | Insurance | Request for Comment:

A New Level Of Enterprise Risk Management Analysis: Methodology For Assessing Insurers' Economic Capital Models

1. Standard & Poor's Ratings Services is requesting comments on its proposed changes to its methodology for evaluating insurers' "economic capital models" (ECMs) through a refinement of Standard & Poor's current "enterprise risk management" (ERM) criteria. The term "insurers" in this article comprises both insurance and reinsurance companies.

2. If adopted, the proposed criteria would partially supersede "Application Guide: Assessing Insurers' Economic Capital Models" and "Methodology: Assessing Insurers' Economic Capital Models," which we published on May 15, 2008. These articles remain relevant, however, for their discussions of the broad principles and processes we use to evaluate ECMs.

3. This request for comment is related to our criteria articles "Principles Of Corporate And Government Ratings," published June 26, 2007, and "Refining The Focus Of Insurer Enterprise Risk Management Criteria," published June 6, 2006.

PROPOSAL SUMMARY

4. Standard & Poor's proposes to refine its criteria for analyzing ECMs. As a starting point, the proposed criteria address Standard & Poor's conditions for establishing what the insurance industry terms the "credibility" of an insurer's ECM.

5. Standard & Poor's views an insurer's ECM as an important means of evaluating the insurer's risks within a strong ERM program. In Standard & Poor's view, a credible ECM and a strong ERM program are fundamental to an insurer's management and decision-making processes. The ECM is, however, only one component of Standard & Poor's analysis of an insurer's ERM.

6. In analyzing an insurer's financial strength or creditworthiness, Standard & Poor's generally focuses on the insurer's risk profile and how individual risks are managed. In October 2005, we supplemented our analysis with an analysis of insurers' ERM capabilities.

7. When analyzing insurers exhibiting what we view to be less diverse or less complex risks, we conduct an ERM level I review. For insurers exhibiting what we view to be more diverse and complex risks and who we believe have implemented a more extensive ERM program, we perform a more extensive ERM level II review as we view ERM to be material to the financial strength and counterparty credit ratings on the insurer.

8. In our experience, some insurers may not have developed robust ERM programs. Others may have developed such programs but for various reasons may not have particularly sophisticated ECMs or, for that matter, risk profiles meriting a detailed ECM review. For such insurers, in our opinion, an ECM review would likely not yield significant

additional insight about the insurer. However, for insurers exhibiting complex risks and who have credible ECMs and a demonstrated ERM culture (such as multiline insurers operating across several countries, with varied and complex product portfolios), we believe ECM reviews could yield information useful for our analysis. We term this analysis the "ERM level III" review.

9. Our proposed criteria describe those parts of an insurer's ECM we would typically analyze in an ERM level III review. We structured the proposed criteria around two sets of modules. The first set of modules analyzes "indistinct" risks such as the approaches an insurer uses to model total targeted resources, to value liabilities and assets, to model potential exposures to indirect risks such as pension fund risk and to model the effect of management decisions, diversification, and capital fungibility. The second set of modules (illustrated in chart 2) analyzes the insurer's modeling of exposure to "distinct" financial and nonfinancial risk groups like market risk, credit risk, operational risk, and insurance risk. This second set of modules is covered in the appendix of this article. Within each of the risks, we have articulated the criteria around five categories to be reviewed, namely: methodology, data quality, assumptions and parameterization, process and execution, and testing and validation. We will assign a score of "basic," "good" or "superior" to an insurer's approach for each category. At the conclusion of the ERM level III review, we will combine the scores assigned to each category within each risk to form an overall credibility assessment of an insurer's ECM.

10. Our proposed criteria also describe how the results of our ERM level III evaluations will affect our ratings.

11. If adopted, the proposed criteria will be applied to our ERM level III evaluations of insurers.

SPECIFIC QUESTIONS FOR WHICH WE ARE SEEKING A RESPONSE

12. Standard & Poor's is seeking responses to the following questions:

- What are your views about our proposed criteria for reviewing insurers' ECMs? (paragraphs 14-134)
- What are your views about our proposed scoring of each risk module as "basic," "good" or "superior"? (Appendix; paragraphs 135-264)
- What are your views about "total targeted resources" and the "M-factor"? (paragraphs 28-46)
- What are your views about our proposal to calibrate the outcome of our analysis of an insurer's ECM with Standard & Poor's own risk-based capital model? (paragraphs 49-56)
- What are your views about our proposal to cap an insurer's ERM score at "strong" for those insurers that apply ECMs that we do not view as credible? (paragraphs 47-48)
- What are your views about the clarity of our proposed definition of "economic capital"? (paragraph 15)

IMPACT ON OUTSTANDING RATINGS

13. Overall, we do not expect significant rating changes if the proposed criteria were to be adopted. We note that existing ERM scores will not be affected until we have completed our ERM level III evaluations.

RESPONSE DEADLINE

We encourage all market participants to submit written comments only on the proposed criteria by July 19, 2010 (60 days from publication). Please send your written comments to CriteriaComments@Standardandpoors.com. Once the comment period is over, we will review the comments and publish our updated criteria.

METHODOLOGY

Executive Summary

14. ERM is one input in Standard & Poor's analysis of insurers and reinsurers. As the insurance industry becomes more complex, the analysis of insurers' ERM also becomes more complex. Many insurers now use ECMs to contribute to their ERM measures.

What is "economic capital"?

15. Standard & Poor's uses the term "economic capital" to mean the financial resources (in addition to reserves and liabilities) required to support an insurer's financial obligations over a stated horizon at a stated confidence level. An ECM is a tool that models the insurer's risks and estimates its risk-specific economic capital.

Why is Standard & Poor's refining its ERM criteria?

16. Standard & Poor's believes that an insurer's ECM is an integral component of an insurer's ERM program. Having analyzed insurers' ERM programs for approximately five years, we now propose to analyze insurers' ECMs to further our understanding of their ERM capabilities and capital needs.

How will the ERM level III review affect our ratings on insurers?

17. If an ERM level III review reveals risk management issues, or we believe the ECM does not adequately quantify the insurer's risks, we would likely change our ERM assessment and our view of the insurer's capitalization. In some cases, this could affect our insurer financial strength and counterparty credit ratings, depending on the severity of the matters identified and their relative importance. However, on the basis of current information, we expect no significant rating changes.

18. We plan to perform ERM level III reviews for all rated insurers. We see the ERM level III review as enhancing our analysis of insurers' ERM capabilities. We also believe the ERM level III review will provide additional information regarding how management quantifies the risks and interdependencies inherent in an insurer's risk profile, resulting in a more developed picture of its capital needs. We also believe that an ERM level III review will achieve more in this regard than what could be achieved by using a risk-based capital (RBC) model (an RBC model is a static formulaic tool wherein factors are multiplied by risk drivers to derive a capital figure). The ERM level III review might also highlight differences between an insurer's ECM and an RBC model.

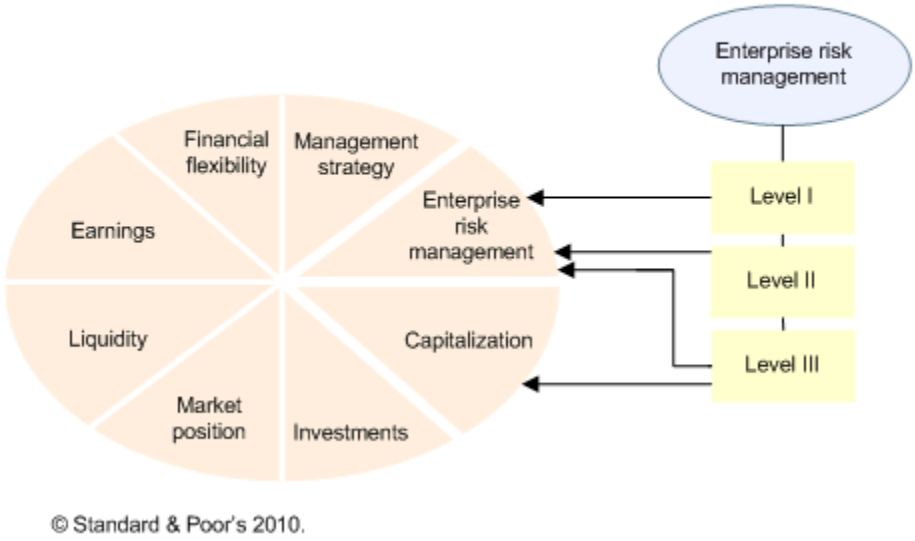
19. The ECM review, along with our review of other risk models, is one of five elements (the others being risk management culture, risk controls, emerging risk management, and strategic risk management) in our ERM analysis. However, we believe an insurer's ECM is integral to its ERM program as it typically feeds into all five elements of an insurer's ERM framework. We believe the proposed ERM level III reviews could provide additional detail in our ERM analyses by providing a more developed picture of how management views and quantifies risks. Because of the importance our ERM criteria places on the economic quantification of risks, we presently expect only insurers with

credible ECMs can achieve an ERM score of "excellent."

20. The ERM review is only one aspect of our analytical process for insurers. Strengths or weaknesses in other areas can offset strengths or weaknesses in an insurer's capitalization and ERM.

21. Chart 1 below shows that the ERM level III review, which feeds into both the assessment of ERM and of capital adequacy (in turn part of the assessment of capitalization), is only one of the factors we use in determining an insurer's credit rating.

Chart 1
The ERM Level III Review In The Rating Context



22. We believe an ERM level III review could reveal management's attitude toward the ECM. For instance, are the model and its limitations understood? Have negatively correlated risk interdependencies, which typically lower capital requirements, been fairly represented and can the basis of the risk offsets be explained? Based on the risk profiles of some insurers, the resulting reduction in indicated capital can be significant. Are the results of the ECM complemented by "what if" scenarios and stress tests? Is the use of the model accompanied by sound judgment?

23. In addition, because these ECMs give a view of the insurer's capital adequacy, we will also likely review the insurer's capitalization along with the ERM level III review. To this end, Standard & Poor's plans to continue using its RBC model to analyze an insurer's capital structure and capital adequacy. But because our static RBC model relies on historical industry averages and the insurer's dynamic ECM program relies on its own risks and their interdependencies, we believe that comparing our RBC results with our analysis of the insurer's ECM results could provide additional information relating to the insurer's capital adequacy.

24. Our capital adequacy analysis involves a grading of the credibility of the ECM through the application of a confidence factor termed the "M-factor." We use the M-factor generally to indicate our confidence in the results of an insurer's ECM in comparison to the results of our RBC model. The M-factor is derived from our analysis of the insurer's ECM. We use the result of our RBC analysis along with our evaluation of the insurer's ECM process to

form a view of the insurer's capital adequacy when combined with other quantitative and qualitative metrics.

The Process For ERM Level III Reviews

25. We plan to undertake an ERM level III review for all rated insurers. The extent of the review will be based, as a threshold matter, on the existence of the ECM. The review will also be based on the extent and availability of documentation supporting the ECM and the insurer's use of the ECM.

26. As a first step, Standard & Poor's will identify insurers that do not, in its opinion, have fully-developed ECMs, as well as those insurers who have not developed a robust ERM framework either because of model deficiencies or because of management's lack of commitment to integrating ECM results into its decision-making processes.

27. The extent of an ERM level III review will be based on the following:

- We will typically only consider an insurer's ECM to be credible if the insurer has an ERM score of "strong" or higher. We expect insurers with ERM scores of "strong" or higher to have risk identification, measurement, and control processes that we believe are adaptable to changing market conditions. We also expect such insurers' ECM estimates to be integrated with their financial management processes when such insurers assess their risk levels, determine their risk appetites, and plan their capital positions.

- We will typically consider the ECM to be credible only if the insurer is applying the ERM results, together with other measures, as the basis of its major decisions (referred to as "embedding" or the "use test" in a regulatory context). We envision that this embedding would generally be implemented through a strategic risk management process (see "Strategic Risk Management: The Upside of ERM," published July 26, 2006). We expect to request documentary evidence confirming use of ECM results, in conjunction with stated risk tolerance levels, strategic asset allocation, pricing, underwriting capacity, reinsurance buying, product design, and performance measurement. We may analyze, for example, whether the insurer's base assumptions are at a minimum consistent with the assumptions used for all of its other projection work such as reserve adequacy or cash flow testing.

- Once we evaluate the two preceding factors, we may request documentary evidence both as to how the ERM program operates to develop reliable estimates of the insurer's risks, and as to how the ERM represents the insurer's enterprise-wide risks. Such documentation is described in our article "Application Guide: Assessing Insurers' Economic Capital Models," section titled "Examples Of Model Documentation Material," published May 15, 2008.

ERM Level III Reviews And Standard & Poor's Capital Adequacy And ERM Analyses

From the ERM level III review to the capital adequacy assessment

28. Standard & Poor's believes the integration of an insurer's ECM into its ERM and thus the insurer's decision-making process is a positive factor for strategic risk management. When Standard & Poor's reviews an insurer's ECM, it typically analyzes capital adequacy in the context of a desired target, such as a desired rating category. It also typically analyzes the insurer's ability to meet its obligations by estimating the effect of stress scenarios on the insurer's balance sheet.

29. In determining an insurer's capital adequacy, Standard & Poor's typically compares its RBC-based capitalization analysis to its evaluation of the insurer's own capitalization analysis, produced by its ECM. Regardless of how an insurer constructs its ECM, we anticipate receiving results for a confidence level and a time horizon, which are consistent with those of our RBC model.

30. We expect to achieve this by comparing the "total targeted resources" (TTR) results from the insurer's ECM to the TTR results from our RBC model (see paragraphs 74-93).

31. Standard & Poor's defines TTR as being the minimum resources sufficient to cover an insurer's specified current and future contractual liabilities, considering future premiums and deposits, over a specified timeframe, according to a specified risk measure and at a specified confidence level.

32. A first element of differentiation among ECMs is the time horizon used. Some ECMs use a one-year approach while others assume a "runoff" of liabilities. Moreover, an insurer might include new business or limit the projection to existing business. We discuss the two different approaches in paragraphs 74-93.

33. An ECM attempts to dynamically simulate the future of an insurance enterprise and often relies on explicit and detailed cash flow projections of the insurer's asset and liability portfolios. Projecting future cash flows we believe enables an insurer to illustrate the nuances of its risk management strategy. For example, such projections can illustrate the effect of dynamic asset-liability management (ALM) and hedging or account for the benefit of reinsurance. Also, many product structures provide for management discretion with respect to participating policyholder dividends and interest credited to policyholder balances, among other things. Although we believe that not reflecting future management actions in the ECM can lead to a misstatement of economic capital, such actions can be difficult to model, because uncertainties of timing and amount can affect results. We discuss this in paragraphs 114-118.

34. Because implementing nested stochastic calculations that allow a full distribution of capital has proven computationally difficult, we have observed that insurers have recently adopted replicating portfolio techniques, which generally make it feasible to calculate the value of assets and liabilities over a large number of scenarios. We discuss this in paragraphs 101-107.

35. A key element in our view of any ECM is the dependence structure. An ECM often relies on economic scenario generators used to model the future values of assets and liabilities. Correlations and copulas are often used to model interdependent movement of random variables. Parametric estimation of a correlation or copula structure can, however, be difficult and unreliable. At the same time, extreme scenarios, such as those leading to a default, can be very sensitive to the selected dependence structure, and we will look to ascertain that the ECM adequately and conservatively recreates extreme-event contagions. We discuss this in paragraphs 119-134.

36. Another aspect of economic capital is the target confidence level. In order to be able to compare the results of our RBC model and insurers' ECMs, we expect that an insurer's economic capital is calculated at a confidence level consistent with the appropriate capital adequacy level of our RBC model. We expect insurers to be able to justify the confidence levels used in their own models. If we consider that the confidence level used is not appropriate for the targeted level of capital adequacy we may request and use results based on a different confidence level. In order to facilitate any comparison, as noted above, we might request that an insurer present its results broadly on a basis consistent with that of the Standard & Poor's capital model (see "Analysis Of Insurer Capital Adequacy," published Dec. 18, 2009).

37. Issues of comparability may arise in relation to the risk measure an insurer chooses to define economic capital. Many insurers have chosen to use the one-year value-at-risk (VAR) concept, while others have adopted other metrics such as conditional tail expectation (CTE), which measures expected losses in excess of a loss threshold implied by their target confidence levels. In this case as well, we would expect the insurer to be able to provide economic capital figures based on a VAR measure, in order to facilitate comparability with our RBC model.

Application of the M-factor

38. As discussed above, there are various ways to evaluate an insurer's development and presentation of its economic capital. Once we have achieved comparability in terms of time horizon, targeted confidence level, and measure of risk to make other economic capital calculations comparable with our RBC model, we typically use a total-balance-sheet approach. For our RBC model, this means that we will determine the TTR. When we determine the TTR for our RBC model, we attribute the adjustments made to the insurer's total adjusted capital (TAC) figure back to the insurer's balance sheet as adjustments to either assets or liabilities. In so doing, we create a pro forma "Standard & Poor's balance sheet" that is consistent with the workings of our RBC model. When we determine the TTR for the insurer's ECM result, we will use information provided by the insurer with any necessary adjustments to ensure consistency with the Standard & Poor's RBC balance sheet. This process attempts to make models determined with different asset and liability valuation definitions more comparable. We then adjust the level of TTR and, ultimately, the level of capital, indicated by our RBC model, using a credibility factor--the M-factor--which is an indication of our level of confidence in the insurer's ECM. The M-factor attributed to the insurer's ECM can affect the ECM's ability to produce a credible result, and our opinion of the ECM's information gathering and calculation processes. We typically constrain the effect of the M-factor in our capitalization analysis by limiting the decrease (or increase) of target capital, so that the change in targeted capital, as calculated under our RBC model for a given confidence level, does not exceed one rating category.

39. While the results of the ECM review will generally not, in and of themselves, directly affect the rating on an insurer, they may influence the ERM score and could influence our view of other aspects of the credit analysis. Table 1 below provides an example of how we may apply the M-factor to the TTR, when an insurer's ECM indicates TTR lower than that resulting from our RBC model. Table 2 provides an example of the possible application of the M-factor when an insurer's ECM indicates TTR higher than that resulting from the RBC model.

40. (The amounts in the tables below are assumed to be in units of currency appropriate for the insurer and are only illustrative.)

Table 1

Application Of The M-Factor When An Insurer Calculates Lower TTR Than Standard & Poor's

	Rating level	
(US$)	**'AA'**	**'A'**
Standard & Poor's target capital*	100	90
Standard & Poor's TTR*	900	890
Insurer's TTR¶ (based on its ECM)	700	
Application of 10% M-factor as per ECM review		
POST M-factor TTR [($700*10%) + ($900*90%)] = $880	880	
Post M-factor target capital§	80	
Reduction in target capital§	20	

Table 1

Application Of The M-Factor When An Insurer Calculates Lower TTR Than Standard & Poor's (cont.)	
Maximum allowed reduction in target capital§ (equivalent to one rating category)	10
Post review target capital§	90
Post review TTR§	890

*Based on Standard & Poor's risk-based capital model. ¶Based on the insurer's economic capital model (ECM). §Standard & Poor's calculations. TTR--Total target resources. Source: Standard & Poor's.

Table 2

Application Of The M-Factor When An Insurer Calculates Higher TTR Than Standard & Poor's		
	Rating level	
(US$)	**'AAA'**	**'AA'**
Standard & Poor's target capital*	120	100
Standard & Poor's TTR*	920	900
Insurer's TTR¶ (based on its ECM)		1,100
Application of 10% M-factor application as per ECM review		
POST M-factor TTR [($1,100*10%) + ($900*90%)] = $920		920
Post M-factor target capital§		120
Reduction in target capital§		20
Maximum allowed reduction in target capital§ (equivalent to one rating category)		20
Post review target capital§		120
Post review TTR§		920

*Based on Standard & Poor's risk-based capital model. ¶Based on the insurer's economic capital model (ECM). §Standard & Poor's calculations. TTR--Total target resources. Source: Standard & Poor's.

41. The reduction or increase in TTR indicated above would be deducted from or credited to an insurer's capital, resulting from the application of our RBC model. The adjusted TTR would take into account the limitation mentioned above, that is, the reduction or increase in target capital, as calculated under our RBC model for a given confidence level, which should not exceed one rating category of capital adequacy (see "Analysis Of Insurer Capital Adequacy").

42. As previously noted, our opinion of an insurer's ECM model can affect our opinion of its ERM which, in turn, can affect the ratings on the insurer. Now we'll examine how we intend to combine the elements of the ERM level III review to formulate a view on the credibility of an insurer's ECM results. In addition, we will explain how this view would translate into an M-factor.

43. When we perform an ERM level III review, the relative significance of each review module within the overall score will vary based on the insurer's risk profile. We will arrive at the M-factor by applying a weighted average of the assessment of each module where the weighting generally will be guided by the risk capital for each risk. However, certain factors in any ERM level III review could prompt us to reach similar conclusions about the insurer's ECM regardless of other facts and circumstances. For example:

- If no material validation work has been performed on the ECM's output, we would likely attach no credibility to such output, meaning that the M-factor would be zero.
- If the insurer assumes a diversification benefit, and the process and assumptions cannot be adequately supported,

we would likely attach no credibility to the ECM's output, meaning that the M-factor would be zero.
- If less than 75% of the insurer's business, as measured by an appropriate metric or metrics is modeled, the M-factor typically would be zero.
- If material unexplained inconsistencies exist between actual results and projected results, the M-factor typically would be zero.

44. We will then combine the scores for the individual elements of the review, attributing relative weight to each element based on facts and circumstances. We note that in cases where most of the scores we assign are "basic" (see paragraphs 60-72), the M-factor would likely be zero.

45. Standard & Poor's will, at least initially, likely assign conservative M-factors to insurers' ECMs. As noted earlier, we may limit the effect of the M-factor by limiting the decrease or increase of the target capital, such that the change in target capital, as calculated under our RBC model for a given confidence level, would not exceed one rating category.

46. For insurers whose ECMs we do not consider credible, we expect to set the M-factor at zero. In other words, we will rely only on the results produced by our own RBC model as part of our analysis of the insurer's capital adequacy.

Impact Of ERM Level III Reviews On Standard & Poor's ERM Analysis

47. Our analytical conclusions following an ERM level III review will contribute to our overall ERM assessment. Because of the importance we attribute to an ECM for risk management purposes, we believe that an ERM assessment of "excellent" will likely only be possible if we find the ECM to be credible, meaning that at the conclusion of the ERM level III review we score each of the five modules (methodology, data quality, assumptions and parameterization, process and execution, and testing and validation) at least "good." Again, our ECM analysis is but one of several considerations determining our overall ERM assessment.

48. For purposes of the ERM level III review, Standard & Poor's analyzes the principles governing how insurers deal with risks in their ECMs, the quality of data, the appropriateness of ECM assumptions, and how the results are produced and integrated into the overall ERM process. The primary considerations are whether an insurer can demonstrate that it has identified and addressed its major risk exposures including how such risk exposures may interact. Risk mitigation, in particular, the assessment of management's strategies for dealing with adverse circumstances, is also important. We will also evaluate how an ECM's results are incorporated into an insurer's risk-management and decision-making policies--for example, whether an insurer reduces its exposure to a particular risk if the ECM indicates that the exposure exceeds stipulated risk limits. To reiterate what we stated above, we generally would not consider an insurer's ERM to be "excellent" unless we were of the opinion that its ECM was credible. Additionally, within our review of an insurer's ERM, we generally would not consider an insurer's strategic risk management "excellent" without evidence that its ECM demonstrated a credible economic quantification of its risks. Lastly we generally would not consider risk models within the ERM review to be "excellent" if the ECM were not credible.

Calibration With Standard & Poor's RBC Model

49. To determine the ERM level III assessment, Standard & Poor's will use the results from the insurer's TTR as calculated, consistently with the insurer's ECM, along with the TTR derived from Standard & Poor's own RBC

model. The calculation is subject to the limit to the decrease or increase in TTR to within one rating category of the target capital under the RBC model.

TTR calibration considerations

50. The following elements may contribute to our view of the TTR:

51. ***Credit rating and confidence levels.*** Within a given time horizon, insurers usually express the confidence level as one minus the average probability of default of the insurer. For example, many 'AA' rated firms--banks and insurers--employ a confidence level of 99.97% over a one-year time horizon, reflecting industry perception that 'AA' rated firms tend to have a long-run average annual default probability of three basis points (bps).

52. Standard & Poor's believes that the insurer's confidence level should be consistent with its modeling assumptions, such as the default probability assumptions the insurer assigns to its own counterparties and obligors for assessing credit risk. Although Standard & Poor's does not ascribe a specific "default probability" to each rating category (because default rates for all rating categories rise and fall over time), we recognize the need to correlate confidence levels with rating categories.

53. ***Time or "at-risk" horizon.*** We presently base our RBC model on a one-year stress period applied to capital. We acknowledge that some firms produce multiyear models, and, in this section, we provide guidance on how we will compare such results to our RBC model.

54. ***Risk measure, such as value-at-risk.*** We will generally evaluate TTR calculations based on the VAR approach. We acknowledge that some insurers use other metrics such as CTE, which measures expected losses in excess of a loss threshold implied by an insurer's target confidence level. Although we believe CTEs can be useful, we do not use them as part of our capitalization analysis.

55. ***Present value versus future value.*** Different insurers use different approaches to assess capital adequacy and insolvency. Some of these approaches attempt to model insolvencies as they may happen in the future. Others attempt to bring these future insolvencies into the present balance sheet. Regardless of the approach, we will analyze the ECM's discounting methodology. Are the projected valuations of the liabilities in line with the modeled future state of the market? And do they reflect various changes, such as the macroeconomic environment along with changed valuation parameters such as discount rates, the assessment of risk (including potentially adverse reserve movements), the consistent discounting of asset and liability cash flows, and the ECM's accounting for asset-liability matching?

56. ***Calibration mechanism.*** In order to facilitate the comparison between an ECM and our RBC, we will analyze insurers' reported results using a VAR measure. A CTE calculation would not, in our opinion, be appropriate for such analysis because our RBC model is constructed using VAR-based metrics. In addition, we would expect firms to have built in mechanisms to calibrate TTR to various confidence levels that correspond to their credit ratings, as well as to various time horizons.

Criteria Framework For The ERM Level III Review

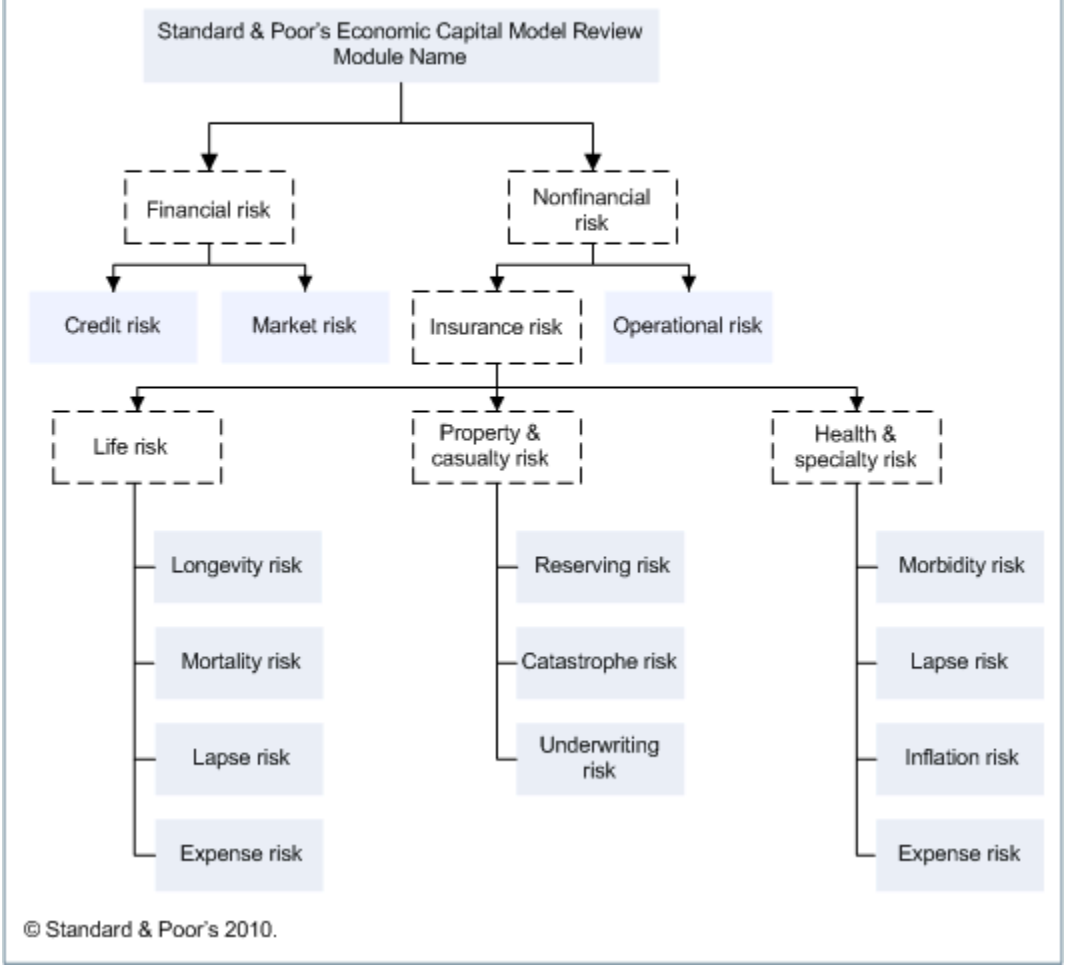
57. We have structured our criteria framework around two sets of modules. As previously mentioned, our review will place more weight on those modules most relevant, in our view, to the risk profile of the insurer. We have designed the first set of modules to analyze risks that are not modeled explicitly as exposures to distinct risk groups, but are applied as modeling considerations. These include:

- Approaches to model TTR, such as one-year versus multi-year.

- Techniques adopted for valuation and stress simulation of liabilities and assets, including specific tools such as replicating portfolios.
- Significant sources of risk that may also be based on the underlying risk groups, such as pension fund risk that has exposure to both market risk and longevity risk.
- Other important considerations such as modeling the impact of management actions, diversification, and capital fungibility concerns.

58. As chart 2 below shows, we have designed the second set of modules to analyze the modeling of exposures to distinct financial and nonfinancial risk groups, such as market risk, credit risk, operational risk, and insurance risk. We describe these modules more fully in the Appendix.

Chart 2
Criteria Modules For Analyzing Insurers' Modeling Of Exposures To Distinct Risk Types And Groups



59. Within each module, we have articulated the criteria around five categories: methodology, data quality, assumptions and parameterization, process and execution, and testing and validation. We cover the categories of results and governance, separately, as they apply to the overall model rather than to each specific module.

Guiding principles and criteria applied across all modules

60. This section describes how we intend to analyze an insurer's individual risks. We believe the approach emphasizes the common principles and criteria across all modules. In general, we will analyze each risk with respect to the five categories mentioned above and assign a score of "basic," "good" or "superior." We will then combine the scores to arrive at the M-factor, our view of the credibility of the ECM, as described in paragraphs 28-46.

61. Table 3 shows the characteristics we would expect insurers to demonstrate within each of our score categories.

Table 3
How Standard & Poor's Scores An Insurer's Approach To Risk

Risk score		
Basic	Good	Superior
• The insurer's approach appears rudimentary relative to the significance of the risk. • The insurer's approach appears rudimentary in comparison with peers and has limited capabilities. • For a given risk, the insurer's risk management practices appear undifferentiated across its business lines. • The insurer addresses some but not all of the considerations of the risk that is being evaluated. • The insurer appears to have limited governance processes, if any, regarding the risk.	• The insurer's approach appears more flexible and advanced than for insurers we score as "basic." • The insurer shows some evidence of developing and applying best practices to develop appropriate risk management practices for its risks. • The insurer may not consistently apply governance processes regarding the risk.	• The insurer's approach appears to be more flexible and more advanced than for insurers we score as "good." • The insurer appears to consistently apply best practices where appropriate. • The insurer's governance processes regarding the risk appear to be well-structured and consistently applied.

62. ***Methodology.*** The "methodology" category focuses on how an insurer identifies and quantifies its risk exposures and whether it incorporates material considerations in its ECM. We will analyze the approaches the insurer uses to model its risks as well as other considerations for the ECM. We will analyze the insurer's definition of "economic capital" to form an opinion about the adjustments necessary to correlate the ECM with Standard & Poor's RBC model. Subjects for analysis include the insurer's rationale for the approach (e.g., scenario-based, static-factor, or stochastic) the ECM uses to capture specific risks, how the approach in our view achieves a fair representation of those risks, how the approach compares with industry standards, and how the approach fits with the modeling of other risks to fairly capture the insurer's overall risk exposure.

63. While we view a stochastic modeling approach as having some advantages over a strictly deterministic approach, we do not believe that a stochastic analysis, in and of itself, necessarily provides a superior framework for analyzing risk

and establishing a view of capital. Similarly, merely because a projection has stochastic characteristics, it is not "superior" to a deterministic approach. In our opinion, a stochastic projection can provide an unrealistically favorable or unfavorable result depending on, among other things, the number of scenarios generated and the constraints built into the scenario generator. In our view, results of a stochastic approach with such limiting characteristics are likely inappropriate for estimating economic capital within an acceptable confidence interval. In our view, such an approach to modeling may misrepresent the risks inherent to the insurer's business and would likely negatively influence our view of its ERM program. It may also indicate the need for increased capital, should the insurer be exposed to risks that the ECM has not modeled. For these reasons, we believe that a stochastic approach supplemented by sensitivities driven by specific deterministic scenarios, including stress scenarios, is more appropriate.

64. ***Data quality.*** The "data quality" category addresses both the quality of the data an insurer uses for asset and liability valuation--exposure or position data--as well as the historical risk data used to derive the ECM's assumptions and parameters.

65. Although we recognize that insurers collect and maintain data over time on which they base their estimations, we are of the view that it could be beneficial for the ECM if its stress scenarios were based on data derived from one or more unusual circumstances or occurrences falling outside of the normal historical experience. Those insurers that in our opinion have "good" or "superior" approaches to this category might use data that include periods of high stress for the risks being modeled. For example, to stress test the ECM's market and credit risk parameters, insurers often employ data collected during the 1987 and 1929 crashes. Data collected for 2008 will, in our view, likely become an additional benchmark against which to test credit models. Some examples of a nonfinancial stress scenario are the mortality and morbidity rates observed during the influenza pandemic of 1918-19.

66. ***Assumptions and parameterization.*** The "assumptions and parameterization" category addresses the process and governance framework that insurers use to determine the ECM's assumptions and parameters, such as the selection of distributions that best fit the relevant risk variables, and that of assessing and capturing possible tail dependencies among risk drivers. Insurers considered in our view to have "good" or "superior" approaches to this category will have analyzed differences in assumption interdependencies (for instance between stressed scenarios and more benign scenarios) and not, in our opinion, misestimated the degree of correlation between assumptions in varying scenarios. In addition, because of the inevitable uncertainty in estimating parameters and assumptions, we consider that "good" or "superior" approaches will likely assess the effect of alternative assumptions and parameters through sensitivity analyses. Standard & Poor's will evaluate the degree of conservatism embedded in insurers' assumptions.

67. ***Process and execution.*** The "process and execution" category addresses how an insurer integrates into its ECM inputs from data warehouses, risk engines, other model results, and reporting and analysis tools. An insurer considered to have a "basic" approach to this category may, for example, manually input data from various sources into its ECM, a "good" approach when it implements clear procedures and methods to gather, clean, and feed data into the ECM, and a "superior" approach when it has a well-maintained data repository requiring limited intervention to populate its ECM.

68. ***Testing and validation.*** The "testing and validation" category addresses the quality of an insurer's approach to testing and validating all aspects of its ECM, including the insurer's methodologies, interpretation of data and ECM outputs into its ERM program. Because of the inevitable uncertainty of estimating parameters and assumptions, we consider this category as one of the most important aspects of capital modeling. In general, we expect that, where possible, insurers will test parameters, assumptions, and dependency structures while validating methodology through stress and scenario testing at the appropriate confidence levels. Our scores for this category generally will depend on the clarity and extent of the insurer's documentation and its testing and validation.

69. In Standard & Poor's view, validation should approach an ECM's outputs both from a static and dynamic basis. Static validation compares the modeled results from the insurer's ECM with actual totals from various accounting sources. Dynamic validation compares historical actual cash flows and cash flows from the base assumption set of the insurer's ECM. In addition, dynamic validation compares differences in the projected base scenario cash flows with those of other scenarios (including periods of assumed high stress) to verify that the ECM is doing what it is supposed to do.

70. In addition, we will typically consider whether insurers record overall ECM outputs over time to understand trends of capital needs predicted for at least the past three years. We also expect to consider whether insurers track variance between modeled risk and actual behavior in an effort to comprehend and explain the difference.

71. ***Governance.*** Standard & Poor's proposes not to address the "governance" category at the individual risk module level but as part of the insurer's overall ECM analysis. In this category we will analyze the governance structure of the ECM model. In our view, a good modeling governance framework should be characterized by a dedicated modeling team that draws from the insurer's entire resources, both geographically and across functions. Team members should have appropriate training and experience. Initial methodologies, parameterization, assumptions, and subsequent revisions should be fully documented and approved by appropriately designated personnel. Any third-party data and models should undergo assessment procedures in the same manner as internally collected data and internally built models. We will review the projection platform's documentation, particularly if the platform is "home-grown" or "off-the-shelf" with open code that facilitates other user-defined functions. We expect that as part of our analysis the insurer will provide documentary evidence of the methodology, assumptions, and mathematical and empirical basis of the ECM, and to explain and address the ECM's limitations. The ECM's development plans should be documented and maintained. We will also analyze user guides and procedure manuals. We will review whether individuals responsible for the ECM's are trained in the design and function of the ECM and how compliance with operating procedures is documented. We expect that to be scored "good" or "superior" in this category, an insurer will in our view demonstrate consistency of assumptions across business units and well-developed governance of all risk areas.

72. ***Results.*** Standard & Poor's proposes not to address the "results" category at the individual risk module level but as part of the insurer's overall ECM analysis. In this category, we will consider the quality of the ECM's results and the reporting tools used. We will analyze documentation for the ECM's projection platforms. We expect that a score of "good" or "superior" in this category, will likely reflect reconciliation of material differences between actual historical results and those produced by the ECM (as described in testing and validation above). We will analyze the processes and corporate culture in place to form an opinion of whether the ECM's results are adopted by the insurer's ERM program and made a part of its decision-making process.

ERM level III review module criteria

A. Modeling by risk group and type

73. As shown in chart 2 above, this stage of the ERM level III review evaluates the economic capital modeling of the distinct financial and nonfinancial risk groups. Our criteria to evaluate the main risk types, listed below, are detailed in the Appendix:

- Market risk.
- Credit risk.
- Insurance risk, which comprises the following risks: Mortality, longevity, morbidity, lapse, expense, underwriting, reserving and catastrophe.
- Operational risk.

B. Other modeling considerations

74. ***Determining total target resources.*** Of the two approaches for calculating the TTR and its components (the one-year mark-to-market approach and the liabilities run-off approach), Standard & Poor's believes each has its own merits. The standards specific to each approach are discussed below under the "one-year" and "liabilities run-off" headings, while the standards that apply more generally to the ECM are discussed in the "TTR model framework." Both approaches assume a going concern valuation with stable levels of risk exposure. While, as previously noted, we generally define TTR as the minimum resources sufficient to cover an insurer's specified future contractual liabilities, considering future premiums and deposits, according to a specified measure of risk and at a specified confidence level, the definition of its components will vary according to the approach adopted.

75. From a modeling perspective, we have observed that TTR components are calculated using either stochastic modeling or stress and scenario testing. Insurers may use different techniques to determine TTR components for different business units; we do not necessarily view this as a superior technique, but understand it may be unavoidable in some cases. We also note that some insurers will use different models to value different components of the TTR calculation. In these instances, Standard & Poor's will analyze the process used to calculate and aggregate these risks.

76. ***a. One-year approach.*** Under the one-year approach, the TTR is typically defined as the sum of the market consistent value of liabilities, plus the economic capital.

77. Standard & Poor's interprets "market value of liabilities" as meaning the present value of expected cash flows needed to fulfill all the insurer's policy obligations in the ordinary course of business. These cash flows will generally include a market value margin for risk and uncertainty (reflecting the cost of risk) and a market consistent approach for financial assumptions.

78. Standard & Poor's uses the term "economic capital" to mean the financial resources (in addition to reserves and liabilities) required to support an insurer's financial obligations over a stated horizon at a stated confidence level.

79. Insurers using the one-year timeline for the calculation of the TTR develop an economic balance sheet on a mark-to-market basis at the valuation date and subsequently at the end of the one-year period. The market value of liabilities should, for each scenario, be appropriate for that particular scenario.

80. We would likely score an insurer's one-year approach as:

- "Basic" when the insurer calculates the value of liabilities on a deterministic basis, adding the cost of options and guarantees valued on an approximate basis, using "closed form" solutions. Economic capital calculations are based on a simplified set of scenarios, but still explicitly linked to the target confidence level.
- "Good" when the insurer determines the market value of liabilities based on a stochastic model, and when economic capital is based on a series of stress tests. Insurers are, in our experience, likely to select stress tests from among the scenarios generated from a stochastic model, consistently with the target confidence level.
- "Superior" when both the market value of liabilities and economic capital are calculated by a well calibrated stochastic model, accompanied by sensitivity analyses and scenario analyses of extreme events.

81. ***b. Liabilities run-off approach.*** Under the liabilities run-off approach, the TTR is defined as the sum of the total initial assets sufficient to pay all future policyholder benefits and associated expenses, at a chosen confidence level, plus the current value of the liabilities. Under this approach, the definition of the current value of liabilities can vary,

and different valuations of liabilities will generally lead to different splits between an insurer's economic capital and its liabilities. The strict application of the run-off approach requires solvency to be checked at yearend, and this implies recalculation of liabilities at yearend, regardless which valuation basis is adopted. In practice, though, we believe many insurers do not perform the solvency check because there are significant computational difficulties.

82. We would likely score an insurer's run-off approach as:

- "Basic" when the insurer does not check interim solvency. However, we would expect insurers to perform high level solvency checks by, for example, reviewing the results of scenarios at around the target confidence level to check if interim solvency is breached.
- "Good" when the insurer checks interim solvency using approximations, for example by estimating liabilities as the value of future claims plus margins, and by calculating the cost of options and guarantees using "closed form" solutions.
- "Superior" when the insurer accurately checks interim solvency, and when it calculates statutory reserves and capital needs according to the valuation rules.

83. ***c. The TTR model framework.*** Standard & Poor's will analyze the extent to which, in its opinion, an insurer's ECM captures the risks to which the insurer is exposed based on its products, financial assets, and risk mitigation techniques.

84. In Standard & Poor's view, an ECM should be at least as robust and comprehensive as the models used for statutory valuation and reporting and should capture all lines of the insurer's business and reflect all of its product features. The ECM results should be based on similar standards to the reserving and accounting applications of the models the insurer is expected to maintain for regulatory purposes and should capture all business lines and embedded product features. We anticipate the insurer's ECM would be consistent with the insurer's other models (reserving, catastrophe, pricing, and embedded value, among others), unless there are well-documented reasons for differences to exist.

85. We will also analyze how the ECM measures and captures the range of the insurer's risks, taking into account the complexity of its product features. While an accurate measurement of risks relating to the most complex product types will likely depend on a model built on a platform that applies a variety of stochastic techniques and distributions, in our opinion other risks may be accurately measured using less sophisticated techniques.

86. An insurer is typically exposed to a wide range of different risks, including financial, mortality, and catastrophic risks. It is challenging to incorporate the different risks into one modeling platform. Quite often, insurers use different platforms or methods for different types of risks. Models based on several platforms typically require manual intervention and spreadsheet manipulation and thus introduce operational risks. We will analyze the insurer's processes to take a view on how such risks are minimized.

87. In severe circumstances, an insurer could model the effects of management strategies for managing the risk profile and the associated risk based capital position, including modifying discretionary factors changing investment or hedging strategies. Standard & Poor's believes that if the insurer appropriately considers the expected management actions in the ECM, calculated capital needs may provide a better reflection of its risk profile. This may be particularly relevant when the insurer has adopted the "run-off" approach, where the impact of management actions is the greatest. Standard & Poor's discusses its methodology for assessing the treatment of management actions in

models in paragraphs 114-118.

88. The ECM's ability to consider different risks on an interrelated basis across business lines is necessary if it is to accurately reflect the insurer's risk profile. For example, to model adequately complex reinsurance and risk transfer arrangements, the ECM may need to consider a wide range of business lines, as well as the credit risk associated with such arrangements. Similarly, tax calculations may be quite complex and may require detailed considerations across a number of business lines. Standard & Poor's will analyze how the interrelationships of these risks are captured.

89. We believe modeling dependencies between different risks and allowing for fungibility of capital are necessary for the insurer's overall capital calculation, given the potentially large impact of these dependencies on an insurer's capital needs. Modeling these dependencies can be challenging and Standard & Poor's will analyze how they are captured by the ECM as discussed in paragraphs 119-134.

90. Standard & Poor's will not, at this stage, review data quality and assumptions for the TTR, because such reviews are incorporated elsewhere in the ERM level III review.

91. When analyzing a TTR model framework, we will likely score the approach as:

- "Basic" when the valuation process considers the insurer's material business lines and liability features, policy data reflect material policy parameters and risk factors (though high level data grouping may be used), and liabilities are established through standard actuarial valuation methods reflecting the insurer's view of best estimate assumptions, reinsurance and risk transfer issues and tax liabilities are considered where appropriate (but on an approximate basis). We would also expect that the insurer bases economic capital on the estimated increase of the value of liabilities under extreme scenarios calculated by stressing main assumptions with stresses being set at approximately the target confidence level and that it captures dependencies between different risks either through a correlation matrix (variance-covariance technique) or by using scenarios where correlated risks (in particular those with nonlinear dependencies) are stressed together.

- "Good" when the insurer applies a stochastic process to determine TTR. Standard & Poor's also believes that dependencies between different risks should either be built into the ECM or calculated based on a correlation matrix, with correlations adjusted to capture the change in correlation that might exist in tail risks. When approximations are used, for example when the insurer uses portfolio replication, Standard & Poor's will request back-testing and details of the measurement of basis risk.

- "Superior" when, in addition to the above, the ECM is integrated and used to calculate both "best-estimate" liabilities and capital needs (that is, the best-estimate reserves are shown to be equal to the mean of the generated output of the stochastic model), and the ECM is based on the assumed probability distribution of all risks. We would also expect the ECM to include a dependency structure, allowing for the stochastic nature of all material risk drivers, accurately modeling expected management actions and the insurer's reinsurance program and risk transfer programs, and illustrating basis risk with emphasis on whether participating business benefits are calculated consistently with the generated economic scenario.

92. When looking at the process and execution category, we will likely score the approach as:

- "Basic" when an insurer employs extensive manual intervention, values some material lines using simplifications, or when its governance process is not on a level with that used for statutory and accounting valuations.

- "Good" when limited simplification and data grouping are used for material lines of business, a limited number of platforms is used for valuation of all lines, manual intervention by the insurer is limited, material product lines are valued using simplifications, approximate methods such as replicating portfolios (when used) are thoroughly tested, and the governance process is on a level with that used for statutory and accounting valuations.
- "Superior" when the ECM models all the insurer's lines, the insurer's manual intervention is minimal, and the governance process includes checking the ECM, changing the ECM where necessary, and reviewing the means by which new assumptions are signed off. While Standard & Poor's believes that reducing the level of manual intervention is valuable, it looks unfavorably on an absolute "black box" approach under which results are not reviewed and where there is no possibility of manual intervention.

93. We will likely score the testing and validation category as:

- "Basic" when the insurer employs only high level reconciliation to statutory and accounting valuations and high level analysis of change.
- "Good" when the insurer performs a detailed reconciliation to statutory and accounting valuation and employs detailed analysis of change.
- "Superior" when the insurer employs especially extensive reconciliation and analysis of change (for example, for each risk and product line). We will also regard as "superior" a process in which cash flows can be validated to output used for a different projection function.

94. ***Valuation of assets.*** An important consideration in our analysis of a capital model is the process an insurer uses to value assets, which in our view is essential to establish a meaningful measurement of risk. Valuing both financial and nonfinancial assets (for example, reinsurance recoverables) and determining an initial starting balance sheet is one of the starting points for ECMs. Depending on the methodology applied, asset valuations after assumed movements in relevant risk drivers or at some future time are also important components of an ECM.

95. ***a. Methodology.*** We will likely score an insurer's asset valuation approach as:

- "Basic" for insurers that initially value assets based on book value or on some other accounting based valuation process, although we would expect the insurer to be able to reconcile these values with market values. In these cases, asset valuations after movements in relevant risk drivers or at some future time would likely be based on approximations and would not necessarily be market consistent.
- "Good" for insurers that initially value assets or hedge instruments that have a "deep and liquid market" using market values obtained from an appropriate source, such as a market maker or provider of market information (Bloomberg, for instance). For fixed-income instruments or "plain vanilla" hedge instruments, insurers may derive values using an appropriate fixed-income analytic system and market implied spreads. We will also analyze whether the insurer has considered all embedded options (for example, callable options), with the understanding that certain valuations of complex assets and hedge instruments can be carried out using an approximate "closed form" solution. For us to view an insurer's asset valuation as "good" our analysis would likely reveal that all the insurer's assets (including derivatives) are valued consistently with the scenarios generated in the market risk and credit risk models, though some approximations may be used, and that the values of nonfinancial assets are projected using a simplified approach.

- "Superior" for insurers that use minimal approximations to value complex assets or hedging instruments, in addition to the valuation methods described in the "good" approach above.

96. ***b. Data quality.*** We would likely view approaches to data quality as:

- "Basic" for insurers that use only internal data to value assets, such as book values or cash flow analysis, that rely on a significant grouping of data (all corporate bonds rated 'AA', for instance), and that may not consider nonfinancial assets in the ECM.

- "Good" for insurers that apply data in the "mark-to-market" or "mark-to-model" valuations, taken from a market maker or provider of market information. However, in these cases, we believe that asset data are more reliable when based on asset groupings using average characteristics (such as those for fixed-income assets, the sector, the ratings on the securities, and their duration) rather than on the actual individual securities. When overall data quality is "good", our analysis affords certain leeway to insurers using justifiable assumptions to complete holes in data due to the absence of market observations (for instance, when observable long-term interest rates or spreads are unavailable).

- "Superior" for insurers that take asset data used in their "mark-to-market" or "mark-to-model" valuations from recognized market data sources appropriate for the assets held. In addition, we will analyze whether the insurer uses observable data to construct the term structure of applicable interest rates and whether the insurer scrutinizes and "cleans" the volatility surface (e.g. observed market rates on over-the-counter interest rate swaps) to minimize the effect of erroneous data. We will also analyze whether missing data points are completed through appropriate interpolation and/or extrapolation techniques (for example, splines), and whether all the insurer's assets (including nonfinancial assets) are included in the ECM.

97. ***c. Assumptions and parameterization.*** We will likely score an insurer's approaches to the ECM's assumptions and parameterization as:

- "Basic" when the insurer applies key determinants of asset values, such as spreads and applied volatilities to broad groupings of assets based on specified characteristics, such as sector or rating. We have observed that in a "basic" approach to assumptions, the ECM's modelers often assume that the values of fixed-income assets are modeled to change in a linear fashion and, therefore, would not fully reflect the embedded options (for example, in the case of residential mortgage-backed securities, changes in prepayments would not be reflected). In some cases, the analysis assumes that valued assets follow an assumed profile, such as the insurer's strategic asset allocation target, rather than that of the actual assets held. In addition, due to the grouping of data or lack of data detail, insurers with "basic" approaches may make assumptions relating to future returns on or characteristics of assets, for instance, based on market value sensitivity.

- "Good" when the insurer's "mark-to model" approach used for fixed-income assets assumes the nonlinearity of assets exhibiting such features. In such cases, however, assumptions might be not be detailed and may not be fully calibrated to the market. For equity holdings, insurers with a "good" approach would likely assume that individual securities would behave like an index to allow simplification of modeling by grouping. A typical assumption, for instance, would be that all U.K. equities behave like the FTSE 350 index. We will analyze whether the insurer justifies and supports its assumptions by testing.

- "Superior" for insurers that model individual asset values assuming the actual characteristics of each individual

asset. Insurers with a "superior" approach to their assumptions would likely derive these assumptions from data taken from sound sources, while giving detailed consideration to the data used, including aspects such as frequency, reliability, stability, and capturing of extremes. Insurers with a "superior" approach would likely base their financial assumptions made during the initial valuation used to calibrate distributions for projections (volatility of returns, for example) on observable data analyzed over a suitable period of time to provide sufficient market volatility and a credible data set or stressed scenarios where they believe credible data do not exist. In these cases, initial financial assumptions, such as the term structure of interest rates, would likely be used consistently through the model. Financial assumptions used for future valuations would be consistent with the scenarios generated by market risk and credit risk models, if applicable.

98. ***d. Process and execution.*** In our view, an approach to process and execution likely would be:

- "Basic" for insurers that manually input summary data relating to asset characteristics, or if such data are produced on many systems or spread sheets and requires significant manipulation before being fed into the ECM.
- "Good" when the insurer provides audited and grouped information on asset characteristics from separate systems. We will analyze, however, whether standard workflow procedures existing alongside agreed upon best practices are used to manipulate and feed the data into the models used to determine economic capital. For instance, in these cases, insurers would store Committee on Uniform Security Identification Procedures (CUSIP) numbers on fixed-income securities and download and retrieve relevant characteristics and pricing data from a reliable pricing service or information provider.
- "Superior" for insurers that take individual asset holding information from asset valuation systems integrated into the ECM, thus requiring limited intervention or manipulation.

99. ***e. Testing and validation.*** We will likely regard approaches to testing and validation as:

- "Basic" for insurers that provide only a high-level reconciliation between asset values used by their ECMs and other published information.
- "Good" for insurers whose major business units and assets are reconciled to statutory valuations with appropriate review and revaluation of prices of mark-to-model assets.
- "Superior" for insurers that reconcile asset values used by their ECMs to statutory valuations, including the identification of any applied spread margins in determining discounts or premiums to the asset value, such as unrealized gains. In addition, in a "superior" approach, we anticipate that the insurer will regularly value the prices of mark-to-model securities using appropriate external sources, such as bid side indications from dealers, and that current observable market prices will be validated using the model and current assumptions to ensure that projected market values are reasonable.

100. ***TTR calculation techniques.*** While many insurers calculate the components of TTR using detailed asset and liability models, other modeling approaches have been developed because of the resources required to run such models. In our experience this has proved to be particularly true in commonly used approaches to the calculation of economic capital that employ nested stochastic calculations. One common approach is replicating portfolios, described below. We note, however, that the replication of portfolios is a second-order model that generally trades a measure of accuracy for speed and efficiency. Furthermore, to validate the output of replicating portfolios, we believe that more traditional model output should be periodically made available for analysis and comparison.

101. ***a. Replicating portfolios.*** Some insurers replicate their portfolios to speed up the valuation of assets and liabilities needed for the calculation of economic capital for financial risks. We have observed that replicating portfolios enable an insurer to calculate the value of assets and liabilities over the large number of scenarios necessary to calculate the ECM. The insurer's goal is to find a replicating portfolio of standard financial instruments that matches the behavior of asset or liability portfolios as closely as possible under a wide range of economic scenarios, especially extreme scenarios where the convergence of the replicated and replicating portfolios is most important. The key benefit of replicating portfolios is not increased accuracy, because after all, they are second-order models, or models of models. Rather, their main positive feature is that they de-link financial calculations from the underlying resource-intensive projections of assets and granular liability models. Said differently, the use of replicating portfolios eliminates the need to model complex asset and liability portfolios, and thus reduces models' run times from days to hours. Determining replicating portfolios is straightforward for liability portfolios that do not have embedded options and guarantees. However, replicating complex or long-term options and guarantees is challenging because of the interdependencies of various related risks, especially for markets where suitable financial instruments are not available, for instance, long-term bonds matching interest guarantees in Taiwan. Under this approach, insurers typically use optimization techniques to find the most appropriate combination of financial instruments for the portfolios being replicated. For these reasons (and because of the associated potential for unreliable results, particularly in stress scenarios), we believe that replicating portfolios should be used with appropriate caution.

102. In our experience, insurers use a wide range of instruments to replicate the material risk characteristics of assets and liabilities, in particular the embedded financial options and guarantees. These typically include:

- government zero coupon bonds;
- differently rated corporate zero coupon bonds;
- equity indices;
- property indices;
- swaptions;
- equity forwards; and
- equity, interest, and foreign exchange call and put options with different strikes and maturities.

103. Some of these instruments may not be actively traded and their calibration will likely be more difficult. However, we note that as the population of assets used in the replicating portfolio increases, the amount of time and effort necessary to maintain the appropriateness of the replications increases as well, so some of the benefit is lost.

104. In our experience, optimization methods are used to find a combination of financial instruments that provides a portfolio that closely matches the risk characteristics of the actual portfolio, whether it is composed of assets or liabilities. In our opinion, achieving a minimal replication error is an important factor for the reliability of economic capital results. In other words, understanding the quantitative impact of the achieved replication error is essential for insurers and for our rating analysis.

105. Standard & Poor's will analyze whether in its opinion the replicating portfolios provide a good fit across the tenor of the assets and liabilities over a range of economic scenarios. In particular, we will analyze whether insurers using replicating portfolios frequently review them, as well as the scenarios used for the optimization process. We will analyze the variety of extreme scenarios and "normal" scenarios employed in the ECM. We anticipate that insurers would test the "goodness of fit" of replicating portfolios based on a range of tools including "R2" (value of "r" squared; the explained sum of squares), sensitivities to key parameters, and scatter plotting. In particular, we will analyze the "goodness of fit" in extreme scenarios.

106. ***1. Methodology.*** When an insurer replicates portfolios, we will likely score its approach as:

- "Basic" if it appears that the insurer is creating its replicating portfolios for heterogeneous asset or liability portfolios, or if there are no suitable financial instruments available to represent some critical features of asset and liability portfolios, such as long-term options and guarantees in emerging markets. The market value of the replicated portfolio should be as close as possible to that of the replicating portfolio at time zero. We will analyze whether an insurer is able to fit the replicating portfolio to its real portfolio by using a cash flow matching technique although approaches that seek to match some of the "Greeks" (representations of sensitivities of derivatives to parametric changes affecting the value of a particular instrument or financial portfolio) are also possible. Additionally, elements of what we regard as a "basic" approach would likely include a limited range of optimization scenarios, optimization criteria that, compared with the standards of the industry, are not strict, and allow exceptions to the optimization rules. In a "basic" approach, we might also expect to find that the insurer has no well-established procedure to check replicating portfolios of complex assets and liabilities or to determine whether the portfolio is over-optimized. Under the "basic" approach, we would also expect that replicating portfolios would be infrequently reviewed (usually only annually) for appropriateness.

- "Good" if the insurer employs a wider range of financial instruments that captures the main features of its replicating portfolios and if the valuation approach for such financial instruments is scored at least "good" (as defined in the criteria for valuation of assets above). The insurer would likely feature replication scenarios based on a range of market-consistent and real world projections, as well as extreme scenarios. Insurers would likely use a range of optimization metrics and allow only minimal exceptions to optimization criteria. Optimization would likely be based on a number of "duration buckets", rather than across the whole duration of the portfolios. Insurers would likely perform detailed analysis on difficult-to-replicate portfolios under various scenarios. We would also anticipate that to receive a "good" score, an insurer would likely review portfolios for continued appropriateness in line with the calculations of economic capital.

- "Superior" if an insurer employs an even wider range of financial instruments capturing the main features of its replicating portfolios than those described in the "good" approach above and if we score the valuation approach for such financial instruments as "superior." The insurer would likely feature a larger number of replication scenarios based on a range of market-consistent and real world projections, as well as more extreme scenarios than for a "good" score. Insurers would likely apply optimization over a large number of relevant duration buckets and use several optimization metrics to determine the match of the replicated portfolio (which may include the "R2" value, average error, and maximum error data) to its real portfolio. We also anticipate that the insurer would perform sensitivity analyses of the real portfolios and the replicated portfolios over a range of market swings. We would expect insurers scored "superior" would have optimization criteria that would allow few, if any, exceptions. We anticipate that in addition to using optimization techniques, insurers would compare replicating models against the ECM under various scenarios (including stress scenarios). We also anticipate that the insurer examines the quality of replicating portfolios of complex assets and liabilities portfolios (including complex and long-term options and guarantees) over extreme scenarios. The insurer would frequently review its replicating portfolios.

107. ***2. Process and execution.*** We will likely score an insurer's approach to process and execution as:

- "Basic" when the insurer uses a considerable degree of manual intervention for entering asset and liability portfolios into the replicating portfolio optimization engine or for entering replicating portfolios into the ECM.

- "Good" when the insurer uses minimal manual intervention for entering asset and liability portfolios into the replicating portfolio optimization engine and for entering replicating portfolios into the ECM.
- "Superior" when the insurer's asset and liability portfolios are automatically fed into the replicating portfolio optimization engine and replicating portfolios are also automatically fed into the ECM. We also anticipate that the insurer would perform reviews of results for reasonableness.

108. ***Postretirement benefit plans.*** Many insurers have their own internal postretirement benefit plans. These plans typically offer a range of different benefits, including annuity, disability, medical, and death benefits. Depending on a given plan's design, the insurer could be exposed to significant market, longevity, and morbidity risks. Therefore, Standard & Poor's anticipates that as part of their ERM programs, insurers will likely reflect the risks associated with these plans in their ECMs.

109. The targeted capital for such a plan should, in our view, reflect the estimated funding cost to the insurer under an extreme scenario and be consistent with the target confidence level. We believe that insurers' best estimates of plan liabilities should include the expected cost of future contributions for benefits accrued to date. In our view, funding surplus of these plans would be subject to local regulation, would be included in the insurer's net assets as such surplus, and would not be available to the insurer should it become illiquid or insolvent. Furthermore, the possibility that payment of some benefits may be at an insurer's discretion (as is the case in the U.S. for some postretirement life and medical benefits) should, in our opinion, also be taken into account.

110. ***a. Methodology.*** We generally evaluate the main risks of an insurer's postretirement benefit plans by the same benchmarks used to evaluate the insurer's marketed insurance business (see paragraphs 171-255).

111. We will likely score an insurer's approach to modeling postretirement benefit plans as:

- "Basic" when the insurer bases its modeling on a range of scenarios stressing the main risks--market trends, longevity, salary inflation--in line with our benchmark criteria for each of these risks.
- "Good," when, in addition to the "basic" characteristics immediately above, the insurer's risk modeling is consistent with its modeling approaches for equivalent risks in its business. For example, we would likely assign a "good" methodology score in respect of the same underlying model for the equity exposure of an insurer's external business and its postretirement benefit plan.
- "Superior" when the insurer adopts a stochastic model incorporating multiple risks and the insurer's modeling is consistent with its approach to similar insurance risks.

112. ***b. Data quality, assumptions and parameterization, and testing and validation.*** When analyzing postretirement plans, Standard & Poor's typically employs the same benchmarks for assessing data quality, assumptions and parameterization, and testing and validation as it uses to analyze similar insurance risks. In particular, we analyze whether an insurer validates its valuations of postretirement benefit plans against other valuations, such as accounting and ongoing funding. However, we also believe that some aspects of the ECM used for postretirement benefits may differ from the ECM used for the insurance business. For example, the subject populations will be almost entirely different and will therefore have different characteristics. In our view, an important assumption is the circumstances under which benefits would not be paid, in cases where payment of benefits is discretionary.

113. ***c. Process and execution.*** In our view, the modeling of postretirement benefits will generally be separate from that of the insurance business; model populations are different, the benefits are likely different as well, and benefits may or may not be funded, among other factors. Lastly, we consider that economic scenarios should be consistent when

insurers add the results of this model to those for other areas of risk capital.

114. ***Management actions*** An insurer's management may take action to mitigate risks and thereby reduce the insurer's capital needs. In this section, we consider the modeling of such actions in response to the economic environment, anticipated product profitability, or a deviation in the capital position from the level targeted by management.

115. In Standard & Poor's view, the challenge in modeling management actions is to define those decisions that management will have the willingness, ability, and resources to implement on a timely basis. A management action may have a positive short-term impact on capital needs, but could have a negative medium- to long-term effect on business or future profitability. As such, we will analyze how an insurer models the medium- to long-term impact of management action and reflects it in its capital position. Implementing management actions may also bear material extra costs and we will analyze how insurers include these when modeling their capital needs.

116. In analyzing the effect of modeled management actions, Standard & Poor's will focus on their reasonableness, timing, associated costs, short-term and long-term impacts, and their consistency with the insurer's management practices and past management actions. Some management actions may have already been tested in the past and could tie in with the insurer's general management principles. Others may be modeled on pure assumptions not backed by historical evidence or materially deviate from management's statements of general principle. Standard & Poor's would analyze the effect of the latter actions by, in part, noting the insurer's analysis of underlying assumptions for untested actions if management has not already decided and planned such management actions.

117. In our experience, management actions may be modeled in areas such as investment allocation, profit-sharing, pricing, business strategy, cost reduction, capital management, and corporate restructuring. Possible management actions include:

- Derisking of the investment portfolio by selling the most capital consuming assets, or purchasing hedging instruments.
- Modifying discretionary payments to policyholders from participating business.
- Modifying amounts charged to policyholders, subject to contractual limits.
- Changing the business mix, closing a book of business, or purchasing or adjusting the reinsurance program.
- Implementing changes in cost structure.
- Modifying or stopping dividend payments to shareholders, or modifying interest on hybrid debt.
- Modifying interest credited to policyholder balances subject to contractual minimums.
- Divesting business units.

118. Standard & Poor's will analyze the extent to which we believe management actions could materially deviate from the insurer's strategic orientation. We generally believe that it would be unreasonable, for instance, to assume that an insurer would sell off its equity portfolio when its strategic asset allocation shows a different orientation. We will analyze whether an insurer models its management actions in accordance with its practices and policyholders' and shareholders' reasonable expectations. We will also analyze the modeling for dependencies on policyholders' loyalty (namely, possible changes in lapses and in the number of paid-up policies) and business implications (stemming from competitive environment, for example). When such dependencies lack historical data observations, we anticipate that the insurer would model prudently. We will analyze whether management actions are likely to occur within reasonable ranges and implemented within a reasonable timeframe. For instance, we might view it as unreasonable to model large increases in premium rates within a short time span. We might also view it as unreasonable for an insurer to consider large asset disposals or changes in strategy to reduce capital in an extreme scenario, owing to the

uncertainties about the costs that such disposals or changes could entail. We will also analyze insurers' efforts to explicitly quantify the impact of management actions on their capital needs.

119. ***Diversification and capital fungibility.*** Each insurer diversifies risk differently. Standard & Poor's has classified insurers' risk diversification into several levels, shown in table 4 below.

Table 4

Classification Of Insurers' Risk Diversification	
Level 1	WITHIN RISK TYPES. Risks are standalone within a single risk class in an individual product or business line. Examples: asset credit interdependencies; lapse risk within universal life products with different funding levels.
Level 2A	ACROSS RISK TYPES. Risks are within the same risk class but may run across various business lines. Example: underwriting risks in the motor, fire, and personal property businesses of a property/casualty insurer.
Level 2B	ACROSS RISK TYPES. Risks span different risk classes within the same business entity. Examples: market risk, credit risk, and underwriting risks for any insurer; mortality and longevity risks for a life insurer.
Level 3	ACROSS ENTITIES AND REGIONS. Risks run across different legal entities or business units in multiple regions and are subject to fungibility considerations.

Source: Standard & Poor's.

120. This section will focus on level 2A and 2B diversification across risk types and on level 3 diversification across entities, where we also address capital fungibility issues.

121. Diversification within risk types is either implicitly captured through the assumed distribution of individual risks or explicitly captured if included in the same dynamic model. As such, level 1 diversification is captured in individual risk benchmarks. Consequently, we will not discuss level 1 extensively in this section.

122. Standard & Poor's has observed that there are a number of ways to aggregate across risk exposures. These include using dependency structures in approaches that are either bottom-up (using integrated scenarios) or top-down (using stress testing).

123. In a bottom-up or risk driver modeling approach, most of the aggregation has already taken place within the scenario generator and is embedded within the scenarios themselves. Correlation matrices, copulas, and regressions can be used to model the dependency structure among underlying risk factors that affect risk exposures. A joint Monte Carlo simulation can be performed to integrate exposures across risk types.

124. In top-down risk modeling, economic capital is calculated by risk type, so in order to arrive at an aggregate level of economic capital, assumptions address the relationships between different risks. Correlation matrices or copulas can be used to describe the dependency among the individual risks and can be applied directly to the amounts determined for the individual risks. In most cases, insurers tend to mix-and-match these approaches.

125. Standard & Poor's analyzes the extent of the insurer's review of the techniques it applies to model interdependencies. The assumption of a particular dependency structure can, in our view, have a material effect on an insurer's ECM. In our experience, appropriate historical risk data may not be available in sufficient quantity (or quality) to estimate dependencies reliably. Even if historical risk data are available, direct application of observed interdependencies may be inappropriate. Forward-looking results may end up reflecting spurious interdependencies, and macroeconomic or business-model changes may affect risk interdependencies. We will also analyze how interdependencies are modeled in stress scenarios.

126. Given what we view to be a significant uncertainty in model and parameter selection, we generally consider the insurer's testing and validation processes as an important aspect to diversification modeling. We will analyze how an

insurer tests for interdependencies, recognizing that in some cases, observed data tend to be scarce, limiting the credibility of such tests and validation. We will analyze how risk parameters are modeled as random variables or how parameters may be selected to overstate rather than understate risk interdependencies.

127. We view capital fungibility as an important constraint when insurers quantify level 3 diversification. In our experience, some insurers assume that a decline in capital or a surplus relating to a loss experienced in one business will be covered by excess capital allocated to or held by a different business. In other words, some insurers assume a "one-balance-sheet approach" when assessing sources and uses of their economic capital. In our experience, however, this approach has some deficiencies. For example, if an event occurs in a business line operated in France, excess capital from a Canadian affiliate may not be available to support the event in France. Likewise, if a significant property/casualty (P/C) loss were to be sustained by one entity, capital may not necessarily be movable from the entity's life insurer affiliate to support the P/C loss.

128. In Standard & Poor's analysis, implicit or explicit assumptions about the fungibility of capital are typically analyzed for consistency with the assumptions of the relevant regulatory authority, taking into consideration potential tax effects. Standard & Poor's will analyze an insurer's assumptions relating to capital fungibility under the various circumstances contemplated in its ECM. For Standard & Poor's to recognize what it views to be a benefit from diversification across entities or regions, it generally analyzes whether such benefits exist after consideration of various "capital traps," such as:

- Minimum regulatory requirements;
- Accounting restrictions, for instance, on dividends;
- Frictional restrictions, for example, on a transfer from one country to another that might incur tax or other costs; and
- Liquidity restrictions, for example, on a transfer that may require the sale of assets or the release of margins, meaning that liquidity might not be available immediately.

129. ***a. Methodology.*** Standard & Poor's will likely score a diversification modeling approach as:

- "Basic" when an insurer considers interdependence partially or generically through a high level correlation matrix, with little or no empirical justification.
- "Good" when an insurer applies empirically derived dependency assumptions to determine interdependence among major risk drivers, for example by using Gaussian copulas or a correlation matrix. We will analyze the extent to which these tools are calibrated to tail correlations using stress scenarios, with such scenarios capturing complex dependencies and fungibility of capital between the insurer's relevant business or investment entities.
- "Superior" when an insurer aggregates economic capital using a set of fully-integrated scenario-driven models with joint Monte Carlo simulation to integrate exposures or a copula approach (e.g. "T"-copula) that adequately captures tail dependencies. In addition, insurers we score as having a "superior" approach would likely perform extensive scenario testing (including stress scenarios) to capture complex dependencies--such as dynamic policyholder behavior--and fungibility of capital between the insurer's relevant business or investment entities.

130. We would likely score approaches to capital fungibility to be:

- "Basic" if an insurer adopts a "one-balance-sheet approach," implying that when one part of the insurer's

business is stressed, capital from another unit could be used to support the stressed business, without justification or support.

- "Good" if an insurer applies conservative or otherwise appropriate fungibility restrictions. For instance, an insurer could require that each of its separate entities meet its own regulatory minimum solvency level.
- "Superior" if an insurer's ECM includes the requirement that (i) each of its regulated entities meets its minimum stand-alone capital adequacy on a regulatory basis, after considering an appropriate level of regulatory intervention (as a result, it is likely the modeled target capital will exceed the absolute regulatory minimum) or any pre-agreed reputation limit on capital adequacy to carry on normal business; (ii) liquidity restrictions appropriately reflect the type and quality of the insurer's assets in which capital is invested and are a gauge of their relative liquidity and marketability following stress (e.g. the transfer may require the sale of assets or the release of margins; the proceeds might not be available immediately); (iii) in cases where excess capital is necessary to be moved from one entity to support another, the insurer provides an analysis of the plan for its transfer, an accompanying analysis of the "costs" of transfer (including tax and other frictional costs) and an analysis of the source and anticipated timing of liquidity; and (iv) in cases where an entity is assumed to be sold, the insurer provides an evaluation of the timing and cost of the sale, consistent with the stress scenario in which the sale occurs.

131. ***b. Data quality.*** We would likely score approaches to data quality as:

- "Basic" when an insurer uses limited data that do not represent adequately tail dependencies.
- "Good" when an insurer uses external and internal data from a range of sources to capture dependencies at a variety of confidence levels, including tail dependencies. We will analyze the insurer's procedures for the cleaning and interpolation or extrapolation of data.
- "Superior" when an insurer uses particularly extensive internal and external data and includes credible statistics on the interdependencies being modeled.

132. ***c. Assumptions and parameterization.*** We would likely score approaches to assumptions and parameterization as:

- "Basic" when an insurer bases key assumptions on normal dependencies and may adjust them at will.
- "Good" when an insurer's assumptions include tail dependencies implied by data, assuming appropriate data are available. In some cases, the insurer would adjust for known deficiencies in the data. We will analyze the extent to which these assumptions take into account expert opinions and management's view.
- "Superior" when, in addition to the above, the insurer adjusts data for known deficiencies, such as the different behavior of dependencies in extreme scenarios, compared with scenarios closer to the mean of the distribution.

133. ***d. Process and execution.*** We would likely score approaches to process and execution as:

- "Basic" when an insurer applies an assumed correlation matrix when determining capital needs for individual risks (e.g. interest rates), while any fungibility constraints are considered using only high level adjustments outside the individual risk models.
- "Good" when an insurer models dependencies using a simplified technique that aggregates the results of individual risk models. We anticipate that fungibility constraints applied in the model would be detailed but done

outside the individual risk models.

- "Superior" when the insurer simultaneously (i.e., during the main stochastic run) considers dependencies between all major risk drivers with minimal manual intervention. Furthermore, under a "superior" approach, we anticipate fungibility constraints would be supportable and taken into consideration in the ECM.

134. ***e. Testing and validation.*** We would likely score approaches to testing and validation as:

- "Basic" when an insurer has not validated its assumptions relating to the fungibility of capital and assumes a single economic balance sheet with no restrictions to capital mobility. A "basic" score also implies that the insurer will not have tested applied dependencies and correlations with techniques such as "goodness-of-fit."
- "Good" when some validation of fungibility is considered, though unintended consequences may not have been fully explored.
- "Superior" when the insurer fully validates its assumptions relating to the fungibility of capital and tests dependencies using appropriate statistical techniques.

APPENDIXES: MODELING BY RISK TYPE AND GROUP

Appendix 1: Market Risk

135. One of the ways Standard & Poor's uses the term "market risk" is to describe the potential economic losses of insurers deriving from financial market conditions. When analyzing an insurer's ECM, therefore, we analyze how the ECM identifies and accounts for the various market risks which might affect the insurer. In particular, we will analyze how the ECM treats an insurer's assets, liabilities, and hedge instruments in light of possible market changes. More specifically, we will analyze how the ECM models potential portfolio losses caused by systemic macroeconomic factors (interest and foreign exchange rates, and commodity and equity prices), market variables (absolute and relative movements in interest rate spreads under various conditions) and as a consequence of the portfolio's composition (fixed income, equity, and other financial assets, exchange traded and over-the-counter (OTC) hedge instruments, and various liabilities).

136. We will also analyze how an ECM's market risk modeling integrates with its modeling of liquidity, credit, and insurance risks. For example, we would expect that an ECM's treatment of an annuity contract would involve not only its modeling of market risk but also of lapse and mortality risk. We would evaluate market risk by analyzing the ease (in terms of timing and volume) with which a hypothetical liquidation of portfolio assets to pay amounts due under the annuity could be executed under a market scenario. We will analyze how and to what extent the ECM treats periods of market illiquidity and how an insurer's potential economic losses might be affected due to this and similar exposures.

137. Certain risks, such as credit quality migration risk (single-name risk) or systemic spread movement are not, as a matter of industry practice, consistently classified as either credit risk or market risk. Under our analysis, an insurer's ECM could treat these risks either as a market risk component or as a credit risk component, but not both risks.

Methodology

138. We would likely score an insurer's approach to market risk as:

- "Basic" when it models market risk drivers and assesses them stochastically in conjunction with other risk drivers, while applying a generic correlation matrix with non-empirically-derived coefficients. The ECM, for example, might not capture all material market risks as when it might attempt to capture exposure to interest rate risk using a sensitivity measure such as duration, rather than measuring exposure at critical points along the relevant term structure, using either a percentage or an absolute change approach. Other exposures, such as secondary measurements of interest rate risk (vega or gamma) or higher order movements related to equity prices might not be captured by the ECM or would be grouped into broad categories or "buckets." In addition, financial market risk variables that cause changes in a portfolio's economic value based on the measured exposure are less detailed than under more refined approaches. The ECM, for example, would evaluate market risk by aggregating risk attributable to components (e.g., interest rates, foreign exchange rates, and equity prices) without analyzing the correlation between the risks or by applying a simplified approach, such as the variance-covariance technique using a correlation matrix. A "basic" approach would also likely assume a normal or other arbitrary distribution to derive applied market movements based on observations over a given period for the actual or proxy market variables applied as risk drivers. Finally, the ECM relies more on estimated sensitivities and uses assumptions on linear risk or price movement.

- "Good" when it estimates correlation coefficients empirically, models market risk stochastically, and analyzes all major risk drivers. In a "good" methodology, the insurer employs a simulated stochastic process that evaluates risk interdependence while modifying the dependency structure for extreme market scenarios. The insurer may also employ other techniques such as stress testing to determine capital adequacy in extreme scenarios and would ensure that these techniques encompass material issues relating to the nonlinearity of certain market prices. In addition, under a "good" approach, the risk bucketing would be fairly granular and would cover all major market drivers. Standard & Poor's will analyze whether the model evaluates the liquidity of hedge instruments or financial assets.

- "Superior" when it models risk drivers' dependency through a market-derived dependency structure, when it runs a more extensive range of risks and extreme events than under a "basic" approach, and when it employs a simulated stochastic process and analyzes the simultaneous movement of market risks. In a "superior" approach insurers would, where relevant, apply techniques using a varying dependency structure involving various market risk drivers allowing for extreme event contagion. In a superior approach, the insurer addresses material correlations among market risks, including sector correlations that realistically reflect extreme market movements to mitigate possible limitations in assumed distributions. Also, the insurer models nonlinear price movements for its assets, liabilities, and hedging instruments. The model captures material component market risks drivers and market interest rate risk drivers measured at material points along the relevant term. The ECM analyzes and buckets secondary measurements of interest rate risk and higher order movements related to equity prices and it illustrates the financial market risk variables that affect economic value. The ECM's market risk component quantifies liquidity risk based on an assessment of the time necessary to close or adjust risk under different market conditions according to the insurer's internal risk policies and the size and positions relative to the market size. Lastly, the ECM analyzes market risk in a diversified and undiversified fashion and allows for decomposition by magnitude and source of risk.

139. Standard & Poor's will analyze the approach used for the following market risk drivers:

140. ***Yield curve modeling.*** We will likely score an insurer's approach to yield curve modeling as:

- "Basic" when ECM involves modeling interest rate movements at select points on the yield curve. The primary focus of such modeling would be to capture yield curve "shifts," or measures of the degree to which a curve has moved upward or downward, in parallel, across all maturities.
- "Good" when additional techniques, such as principal component analysis, are used to identify and calibrate additional yield curve risk factors, such as "twists" and "butterflies," at selected points on the yield curve. In yield curve modeling, twists capture the degree to which the curve has steepened or flattened, and butterflies capture the degree to which the term structure has become more or less convex.
- "Superior" when apart from identifying the additional yield-curve risk factors and applying these only at selected points on the yield curve, it incorporates a full-term structure framework to fully model these relevant sensitivities across the entire curve. In our view, some examples of such frameworks might include the arbitrage-free, full-term structure Hull-White and Heath-Jarrow-Morton models.

141. ***Interest rate risk positions modeling.*** We would likely score an insurer's approach to interest rate risk positions modeling as:

- "Basic" when it analyzes only lower order components of exposures (for instance, delta, but not gamma or vega) and it does not comprehensively capture basis risk or measure component exposures.
- "Good" when it does not comprehensively model basis risk, and measures only a subset of major component exposures but does not necessarily evaluate them at the most relevant points along the term structure.
- "Superior" when it minimizes model risk, comprehensively measures component exposures such as delta, gamma, vega, as well as spread movements at the most relevant points along yield curves, and evaluates the effect of simultaneous rate movements on insurance products.

142. ***Foreign exchange rates modeling.*** When evaluating methodologies for modeling foreign exchange rate (FX) risks, Standard & Poor's will analyze the spot and forward FX rates in an insurer's model, with underlying yield curve models based on interest-rate parity assumptions.

143. ***Commodity contracts modeling.*** When evaluating methodologies for modeling commodity risks, Standard & Poor's will analyze the approach insurers use to determine commodity prices based on structural macroeconomic models.

144. ***Equity modeling.*** Standard & Poor's will analyze whether the insurer models equities stochastically, possibly by using appropriate indices as a proxy for modeling portfolios of individual stocks.

145. We would likely score an insurer's approach to equity modeling as:

- "Basic" if the model does not fully analyze extreme equity movements (for instance, the models assume a distribution for equity returns that does not have fat tails). In addition, these models would likely not attempt to capture basis risk reflecting differences between movements in the actual portfolio and a modeled index, if applicable.
- "Good" if the model at least generally captures the potential for extreme equity movements and analyzes basis risk, though perhaps not comprehensively.

- "Superior" if the model is based on more sophisticated techniques to model equity exposure (such as modeling the stochastic volatility of equity returns) than found in a "basic" or "good" approach.

146. ***Modeling of miscellaneous equity holdings.*** Miscellaneous equity holdings include certain minority interests in companies and private equity holdings.

147. We would likely score an insurer's approach to miscellaneous equity modeling as:

- "Basic" when the insurer applies a charge as a percentage of the portfolio value.
- "Good" when the insurer assesses the risk based on a model that uses observable proxies.
- "Superior" when the insurer uses proxies but reflects in the model the basis risk between the actual holdings and the proxies used.

148. ***Modeling of real estate holdings.*** We would likely score an insurer's approach to real estate modeling as:

- "Basic" when the insurer models the risk as it does equity risk. In other words, if the insurer estimates capital for real estate replacement value risk as a percentage of the real estate's book or written down value.
- "Good" if the insurer estimates capital based on a statistical approach relating to historical real estate value movements, including stress periods.
- "Superior" if the insurer estimates capital, not only based on historical data but also through measuring the variability of real estate value risk drivers (such as macroeconomic variables), simultaneously with other financial and nonfinancial risk drivers.

149. ***Market liquidity risk modeling.*** We would likely score an insurer's approach to market liquidity risk modeling as:

- "Basic" if the insurer only analyzes potential market illiquidity when modeling its market risk capital.
- "Good" if the insurer analyzes potential market illiquidity, and generally integrates it into its model.
- "Superior" if the insurer analyzes the effect of potential market illiquidity and then links the liquidity horizon assumptions to market liquidity of the underlying instruments based on the size of positions.

Assumptions and parameterization

150. We would likely score an insurer's assumptions for market risk as:

- "Basic" when it assigns static values to risk drivers or generally assumes that such values follow an arbitrary distribution, such as a normal distribution. A "basic" approach is also likely to be characterized by the insurer grouping its portfolios into generic classes without assessing potential basis risk.
- "Good" if it empirically estimates its risk drivers' parameters, while assuming they will follow generic distributions without back testing. Another characteristic of the "good" approach would be when the insurer groups its portfolios into generic classes with basis risk assessed. In a "good" approach, insurers would also assess their risk drivers' possible tail dependencies.
- "Superior" if it assumes that its risk drivers follow market-consistent distributions and if it estimates risk drivers empirically using techniques such as maximum likelihood and moment-matching, among others, while also

assessing its risk drivers' possible tail dependencies. In a superior approach, the insurer would also analyze the amount of data used (including a focus on frequency, reliability, stability, and capturing of extremes). A key difference between "superior" and "good" assumptions, in our view, is the robustness of procedures used to derive the assumptions for variables for which available market data are somewhat limited.

151. Regardless of scoring, Standard & Poor's will typically analyze an insurer's modeling assumptions to determine the extent to which they reflect the insurer's concentration limits, stop-loss limits, limits on position types, and the timing for adjusting "out of bounds" risk exposures. One characteristic of a "basic" score could be that the model assumes that price or market value movements behave in a linear manner, while approaches we score as "good" or "superior" would assume that the price movements of many financial instruments are nonlinear. Characteristics of a "basic" approach could involve the model assuming that covariance remains stable as markets move, while under a "superior" or "good" approach, the model might capture the expected movement. In a "superior" approach to liquidity issues, the model might make assumptions on the timing of asset sales as well as taking into account the size of positions relative to the size of the market. Under a "superior" approach, the insurer would likely provide the analysis underpinning the assumptions relating to basis risk used to map proxies to risk drivers.

Data quality

152. We would likely score an insurer's data quality as:

- "Basic" when the insurer relies on asset data generically grouped into buckets based on similar characteristics (e.g., corporate bonds rated 'AA'), or proxy data (e.g., index data used to represent mutual fund exposure), which may not have been vetted or adjusted, as appropriate.
- "Good" in cases where the insurer has applied what we view as reasonable assumptions to adjust for missing data due to a lack of market observations (e.g., an absence of long-term interest rates). In situations where full or partial data on specific market risks are not available, we may also review techniques used to create proxy data. In scoring an insurer's approach to data quality as "good," we evaluate the processes it uses to validate market data (e.g., broker/dealer pricing), the methods it employs to construct the term structure of interest rates and relevant volatility surfaces, the techniques it uses to evaluate and cleanse data to minimize the impact of erroneous data, and the methodologies it employs to address missing data points (including the use of robust interpolation or extrapolation techniques such as splines).
- "Superior" if the approach has all the features of a "good" approach, described immediately above, and in addition it incorporates, in our view, systematic data quality control processes and appropriately executed internal reviews.

153. For data time horizons, we would likely score an approach as:

- "Basic" if an insurer analyzes historical data relating to movements in individual market risks over what we regard as a statistically significant time period for the risk being analyzed and which we believe is representative of expectations of future movements.
- "Good" if we are of the view that the historical data record spans time horizons supported by testing and justified effectively by management, and includes specific scenario data relevant for stress testing for the most significant risks.
- "Superior" if the approach has all the features of a "good" approach, as outlined immediately above, and in

addition includes specific scenario data relevant for a broad range of stress testing.

Process and execution

154. We would likely score an insurer's approach to process and execution as:

- "Basic" if the insurer models market risk as a stand-alone risk, calculating capital for individual market risk drivers.
- "Good" if the insurer models market risk together with other financial risks and then aggregates them with nonfinancial risks.
- "Superior" if the insurer models market risk events with other risks during the main stochastic run, based on a market-implied dependency structure.

Testing and validation

155. We would likely score an insurer's approach to testing and validation as:

- "Basic" if the insurer back-tests parameters but does not stress test portfolio losses.
- "Good" if the insurer back-tests risk drivers (but not correlation structure or parameters) and portfolio losses against stressed scenarios.
- "Superior" if the insurer back-tests risk drivers with historical data of, in our view, appropriate lengths, back-tests risk correlation structures and parameters with historical data, and stress tests extreme predicted portfolio losses at high confidence levels.

Appendix 2: Credit Risk

156. In analyzing ECMs, Standard & Poor's is of the view that credit losses experienced by insurers largely result from credit defaults, credit quality migration (i.e. rating transitions), and, depending on the risk classification, systemic and idiosyncratic movements in credit spreads. Standard & Poor's is also of the view that the increased tradability and transferability of credit risk in recent years has blurred the line between market risk and credit risk for many fixed-income assets. Consequently, Standard & Poor's ECM approach analyzes the extent to which these "gray area" risks (e.g., idiosyncratic spread risk or credit quality migration risk) are treated as credit risk or market risk. Standard & Poor's is also of the view that these risks, if material, should be analyzed under one or the other category.

157. The source of these credit risks may include fixed-income assets, credit derivatives, commercial mortgages, reinsurance contracts and over-the-counter (OTC) derivative contracts. In our evaluation of an ECM's approach to credit risk, we analyze the extent to which credit risk mitigation techniques such as collateral support annexes (CSAs), absolute and relative concentration limits, underwriting standards, guarantees, "short" credit derivatives and wind down provisions may affect the risk profile of an insurer, especially as regards the mitigation of concentrated exposure.

158. We also recognize that certain types of credit exposure and the related loss severity or loss given default (such as exposures to OTC derivative contract or reinsurance contract counterparties), may change based on movements in the financial or insurance risks that underlie such contracts. In our opinion, the magnitude or degree to which

certain credit risk mitigation strategies offset modeled exposures may be directly linked to movements in underlying market variables (this has emerged as particularly relevant in the recent financial market downturn). Accordingly, we will analyze the credit risk portions of ECMs not only in the context of the methodology insurers use for simulating or applying the frequency and timing of defaults, but also in the context of how ECMs capture loss severity, given default. Along the same lines, we would evaluate the methodology used to scale credit quality and the techniques used to link this methodology with the frequency of default. We would also analyze the degree to which the insurer actively trades the source of the exposure and the insurer's hedging assumptions, if any. In addition, we would analyze methodologies for evaluating the interrelationship between default frequencies for various exposure types.

159. In sum, Standard & Poor's believes that the major drivers of measuring credit risk in ECMs include default probability, default correlations, recovery or loss given default (LGD), exposures at default (EAD), and probabilities of credit quality migration.

Methodology

160. In general, the degree to which we view an insurer's applied methodology as capturing and measuring credit risk based on the targeted level of confidence may lead us to score an approach as "basic", "good" or "superior." Our scoring is based on our opinion of the methodology used to capture each of the main risk drivers discussed earlier.

161. ***Inclusivity.*** We would likely score an insurer's approach as:

- "Basic" when it only captures default risk and LGD.
- "Good" if it largely captures the risks relating to credit quality migration or idiosyncratic spread movements.
- "Superior" if it fully captures the risks relating to credit defaults, credit quality migration, and systemic and idiosyncratic movements in credit spreads.

162. ***Default risk.*** We would likely score an insurer's approach as:

- "Basic" when it measures default risk by applying the frequencies and timings of defaults to obligors, counterparties, and other credit exposures based on multidimensional factors (e.g., tenor and credit rating).
- "Good" when it assigns default probabilities to obligors and counterparties based on cohort assumptions, such as internal or external credit ratings, which the insurer would adjust based on the obligor's risk characteristics and market conditions individually, among others, with appropriate risk differentiation.
- "Superior" when it estimates default probabilities and assigns them to their obligors and counterparties based on market-consistent information (e.g., equity value volatility, bond option-adjusted-spreads, and credit default swap spreads).

163. ***Probability of default correlations.*** We would likely score an insurer's approach as:

- "Basic" when it applies fixed, average, or identical and unstressed or simulated probability of default to all exposure types without analyzing correlations and factors such as seniority, initial credit quality, or sector and risk mitigation.
- "Good" when it uses stressed or average probability of default based on historical data including analysis of correlations with other credit risk drivers under very stressful scenarios.

- "Superior" when the probability of default is modeled simultaneously with other credit risk drivers, including correlation structures capturing tail dependencies, and taking into account the effects of such factors as seniority, initial credit quality, or sector and risk mitigation.

164. ***Recovery risk and LGD.*** We would likely score an insurer's approach as:

- "Basic" when it applies fixed, average, or identical LGDs for all asset classes and debt seniorities without stressing or simulating changes to them.
- "Good" when it uses stressed or average LGDs based on historical data, including analysis of correlations with other credit risk drivers under very stressful scenarios.
- "Superior" when it applies LGDs modeled simultaneously with other credit risk drivers and with correlation structures capturing tail dependencies. Under a "superior" approach, the insurer might also analyze the effects of risk mitigation (e.g., collateral values captured dynamically to address asset price volatility, and correlations with exposures, either through EAD or LGD) and debt seniority.

165. ***Credit exposures and EAD.*** We would likely score an insurer's approach as:

- "Basic" when it measures credit risk using exposures or EADs assumed to be a function of balance sheet carrying values or notional values.
- "Good" when it applies EADs based on historical data together with a process that identifies risk exposures, particularly under stressful scenarios.
- "Superior" when it applies simulated or stressed EADs modeled simultaneously with other credit risk drivers, while applying correlations that capture tail dependencies. A "superior" approach might also capture the impact of risk mitigation techniques (e.g., collateral provisions) dynamically by capturing price volatility.

166. ***Credit quality migration risk.*** We would likely score an insurer's approach as:

- "Basic" when it assesses downgrade risk as a fixed percentage of capital or EAD, or does not assess downgrade risk at all. Under a "basic" approach, an insurer might assume credit risk drivers with static values and assume such drivers follow an inappropriate distribution, such as the normal distribution. In addition, an insurer might assume that credit exposures are infinitely granular and perfectly diversified without analyzing concentration risk.
- "Good" when it assesses downgrade risk using short-term market movements (e.g., as part of a VAR model based on normal or empirical distribution assumptions). Under a "good" approach, an insurer may also empirically estimate credit risk drivers but under the assumption they follow generic distributions without back-testing, with only partial analyses of risk concentrations. Any changes in the interrelationships of the drivers under stressful scenarios should, in our view, be considered as well.
- "Superior" when it empirically captures the likelihood and severity of downgrade risk based on historical transition probability matrices (systemic risk) and spread data (idiosyncratic and systemic risks), among others, with appropriate correlations. In addition, the insurer's model would assume that risk drivers follow distributions calibrated to historical observations and implied statistics, and it empirically estimates those using appropriate statistical techniques, in addition to capturing risk concentrations, including single-name, geographic, industry segment, and asset class exposures, correlations, and tail dependencies.

Assumptions and parameterization

167. We would likely score an insurer's approach as:

- "Basic" when credit risk drivers have static values or if the insurer assumes these drivers follow an arbitrary distribution such as a normal distribution. Under a "basic" approach, the insurer might assume that its credit portfolios are infinitely granular and perfectly diversified.
- "Good" when it estimates credit risk drivers empirically, while assuming they follow generic distributions without back-testing. Under a "good" approach, risk concentrations would be only partially captured. Changes in the interrelationships of the drivers under stressful scenarios would also be considered.
- "Superior" when it assumes that risk drivers follow distributions calibrated to historical observations and implied statistics, and that they are estimated empirically using appropriate statistical techniques, in addition to capturing risk concentrations, correlations, and tail dependencies.

Data quality

168. We would likely score an insurer's approach to data quality as:

- "Basic" when it "buckets" applied data or uses proxy data without quality control.
- "Good" when it collects historical data used to generate key risk driver data without characteristic information.
- "Superior" when its data are portfolio specific with associated characteristic information appropriately classified. Under a "superior" approach, the insurer's risk rating system may also differentiate credit exposures by default risk and loss severity. In addition, the time period to which the data pertain may include at least one severe economic or several credit downturns, and may also contain specific scenario data for stress testing. Under a "superior" approach, the insurer may implement systematic data quality control and review processes. Furthermore, the insurer's system of ranking credit quality may differentiate "credits" by their potential for default and their loss severity and the insurer may integrate material external data sources into its overall data system.

Process and execution

169. We would likely score an insurer's approach to process and execution as:

- "Basic" when it models credit risk as a stand-alone risk without a stochastic generation process and it adds measured capital to the aggregate capital charge.
- "Good" when it models credit risk together with simulated movements in financial market risks and then aggregates the results with nonfinancial risks.
- "Superior" when it models credit risk events (e.g., defaults and migrations) with other risks during the main stochastic run, if applicable, based on a market-consistent correlation structure.

Testing and validation

170. We would likely score an insurer's approach to testing and validation as:

- "Basic" if it back-tests certain but not necessarily all parameters and back tests historically observed losses in stressed environments.

- "Good" when it back-tests the risk drivers and also considers the correlation structure or parameters, or both of these, while testing portfolio losses against significantly stressed scenarios.
- "Superior" when it back-tests risk drivers with historical data of appropriate lengths and coverage while also back-testing risk correlation structures and parameters with historical data and stress-tests extreme predicted portfolio losses at high confidence levels.

Appendix 3: Insurance Risk

Mortality risk

171. Mortality risk arises from the deviation between actual mortality rates and those expected in pricing and reserving. The importance of mortality risk to insurers depends on their product offerings and benefit structures; mortality risk has historically not been a concern for P/C insurers. Most permanent and term life insurance products contain material mortality risk as do many health insurance products and annuities with living benefits. In our view, saving or unit-linked policies with no death guarantees could also be affected by second-order mortality risk effects such as future profit losses. Finally, the impact of a huge mortality deviation--such as from a pandemic--could go beyond life insurance, due to the possible interactions it may have with market, lapse, and operational risks (see paragraphs 119-134).

172. In our opinion, the challenges in modeling mortality risk reside in:

- Projecting trends. Past decades have witnessed substantially improved mortality rates. The challenge is in recognizing this trend while prudently extrapolating future changes according to jurisdiction, postcode, sex, age, industry code, smoking status, cause of death, as appropriate to the product being modeled.
- Estimating mortality volatility to simulate the future distribution of mortality. We note that the volatility of mortality results is a function of the size of the insured population under review and in our view becomes gradually less relevant as the population gets larger.
- Enumerating and capturing the impact of possible catastrophe events. Beyond the ongoing volatility of mortality ratios, exceptional events, such as pandemics, may in our view lead to extreme deviation in mortality rates.
- Taking into account the features of an insurer's own exposure and past data in setting assumptions.

173. In assessing mortality risk modeling, Standard & Poor's analyzes an insurer's modeling sophistication, data grouping, and exposure granularity of the mortality module itself, its integration within the insurer's overall ECM framework, and the identification of the interactions it may have with the other modules.

174. ***Methodology.*** We would likely score an insurer's approach to modeling mortality risk as:

- "Basic" when, in our view, such modeling captures this risk adequately. However, we assume an insurer would base its modeling on assumptions of aggregate or high-level-granularity rates of mortality applied to total exposure-at-risk or volume exposures (specifically loss ratios on premiums or capital charges on reserves), including an allowance for extreme events through an additional mortality charge. Under such an approach, reinsurance may be captured through a justifiable reduction of claims.
- "Good" when, in our view, it includes a more refined approach to capturing the range of possible cash flow

outcomes arising from mortality risk and, where appropriate, capturing the possibility of extreme events, for example, pandemic, terrorism and natural catastrophes. Under a "good" approach, the insurer may employ stochastic valuations, particularly to value the most severe mortality causes, using simulation techniques to allow for full distribution of the risk. In addition, the insurer may value reinsurance or other risk mitigation techniques consistently with the modeling of gross exposures, including, among others, appropriate allowances for incidence rates, severities, and deductibles (health insurance), varying retention limits, reinstatement costs, and accumulation covers.

- "Superior" when it includes highly granular modeling of material risk drivers, taking into account trend risk, the possible change in volatility compared to historical levels, and, where appropriate, the possibility of extreme events, for example, pandemics, terrorism, and natural catastrophes. Under a "superior" approach, the insurer may use stochastic mortality projections for all material risk drivers; it may employ Monte Carlo simulation models that allow for path dependency when a multi-year approach is used. Also, the insurer may employ an underlying distribution function that appropriately reflects tail mortality risks with its approach complemented with scenario-based simulations backed by an appropriate scenario identification process and comparison with the extreme outcomes from Monte Carlo simulations. Under a "superior" approach, the insurer's projections may integrate industry- and entity- specific features, such as events in areas of risk concentrations, and the effectiveness of risk management initiatives designed to mitigate such concentrations. In addition, the insurer's modeling process may integrate the effect of all forms of reinsurance and other risk mitigation techniques along with changes in underwriting standards.

175. ***Assumptions and parameterization.*** We would likely score an insurer's approach to developing mortality assumptions as:

- "Basic" when its models analyze rationales for underlying assumptions, such as underlying probability distribution. Under a "basic" approach, the insurer's model may not explicitly identify the different layers of mortality rates (e.g., it may not split extreme mortality assumptions between general deviation and deviation stemming from pandemics or other causes). Furthermore, the insurer's assumptions may not include the underlying portfolio's experience; rather, the assumptions could be based mostly on industry mortality tables. In the case of multiyear models, under a "basic" approach, the insurer may use a path-dependent model for future simulations of mortality rates.
- "Good" when the insurer includes an allowance for its own experience in setting risk assumptions as supported by a sufficiently detailed past claims database.
- "Superior" when it employs a model fed by highly granular assumptions that extensively rely on the insurer's own experience, while appropriate and documented industry assumptions are applied to new products or generations of products lacking past experience. Under a "superior" approach, the insurer's assumptions may rely on historical data adjusted for known information and allowing for future possible changes (e.g., population mortality improvement or changes in underwriting procedures) mainly if the insurer uses a multiyear approach.

176. ***Data quality.*** We would likely score an insurer's approach to data quality as:

- "Basic" where it "buckets" exposure data (e.g., product, exposure levels, age, and sex). Under a "basic" approach, the portion of unmodeled business may remain limited; the insurer may document any possible effects and scale up results based on volumes. Under a "basic" approach, data may capture nuances of the insurer's

claims history.

- "Good" when it takes a more granular approach to data grouping. Under a "good" approach, the insurer may have multiple grouping criteria going beyond those we score "basic," avoiding data grouping or simplifications that could result in unsupported risk offsets. Under a "good" approach, data may reflect the full exposure, leaving unmodeled business at a nonmaterial level and scaling up the results appropriately. Under a "good" approach, the granularity of data used to derive the assumptions may be suitably detailed with statistics on cause of death, geography, and population type. In addition, the insurer's data may reflect the insurer's current exposure.
- "Superior" if it encompasses data grouping of high but credible granularity, reflects material risk drivers, and avoids artificial diversification and risk offsets that a less granular grouping may imply.

177. ***Testing and validation.*** We would likely score an insurer's approach to validation and testing as:

- "Basic" when it conducts minimum testing and validation for its mortality model, including back testing against actual claim counts and amounts or "as-if" testing with past extreme events or high mortality losses.
- "Good" if it conducts a reasonable range of testing on the results of the model, including back testing, scenario testing (e.g., "past events" testing, real-world scenario identification, and testing against the model's worst outcome), and potential changes in reinsurance costs, mortality bonds, and closed-formulae testing, as appropriate. Under a "good" approach, the insurer may provide some form of reconciliation with existing extreme mortality bonds.
- "Superior" if it demonstrates a wide range of testing and validation. Under a "superior" approach, an insurer may include sensitivities to assumptions, a multiple real-world, scenario-based comparison, back testing, closed-formulae comparison, and reconciliation with existing extreme mortality bonds.

178. ***Process and execution.*** We would likely score an insurer's approach to process and execution as:

- "Basic" if its mortality model is an integral part of the ECM. Under a "basic" approach, an insurer bearing minimal mortality risk relative to its counterparts may run the mortality module separately from the whole capital model, and aggregate back the results while ensuring adequate coverage of material dependencies. Under a "basic" approach, the insurer's model may allow for the effect of mortality risk on future cash flows (i.e., possible cross subsidies between risks), though with a simplified approach.
- "Good" if its mortality model is integrated into the ECM and captures material direct dependencies (e.g., morbidity risks in group contracts) and material indirect dependencies (e.g., the effect of mortality deviation on longevity assumptions).
- "Superior" if its mortality model is integrated into the ECM, if its execution processes are in our view better documented with fewer manual operations than seen in a "good" or "basic" approach. Under a "superior" approach, the insurer will model all dependencies. Compared with those approaches scored as "good," a "superior" approach may provide for the addition and documentation of material impacts on financial or operational risks.

Longevity risk

179. In Standard & Poor's view, analyzing longevity risk is central to the assessment of insurance products where policy terms specify guaranteed or minimum annuity payments (e.g., immediate annuities, structured settlements, and guaranteed minimum income benefits). Insurers writing these products are, in Standard & Poor's view, exposed to the possibility that policyholders may live considerably longer than expected and that ensuing payouts would substantially exceed expected payout amounts.

180. When estimating expected longevity, Standard & Poor's believes it is prudent to establish the product portfolio's current mortality and how this figure could change. Longevity largely depends on socio-economic status and health, among other factors, and we understand that it may be challenging for an insurer to obtain data that adequately capture the portfolio's economic status and health. Typically, except for structured settlements, health information is not available from the subject populations.

181. Over time, longevity has lengthened considerably due to medical advances and lifestyle changes. Overall, the rate of improvement in past years has outpaced insurers' expectations. In the future, we expect that further medical advances and lifestyle changes will likely continue to transform the nature of longevity risk. Consequently, we are of the view that analyzing past experience may not be sufficient to form reliable views of future longevity improvements. We understand that there is currently no accepted industry-wide approach to modeling longevity risk. In the absence of a consensus on expected longevity improvements, the industry is currently considering a wide range of modeling approaches and outcomes.

182. ***Methodology.*** We would likely score an insurer's approach to longevity risk as:

- "Basic" if it bases its model on generally available mortality data while using some stress testing.
- "Good" if it combines relevant industry and insurer-based mortality experience. Under a "good" approach, a model may include considerations based on fitting an appropriate distribution of risk to the insurer's assessment of both best-estimate and extreme longevity. In addition, given the wide range of alternative longevity models, we view as sound practice the analysis of several modeling approaches and appropriate analysis of their impact on results. We consider as "good" the use of stochastic models as they can, in our opinion, better reflect the inherent uncertainties of future longevity. Under a "good" approach, insurers may take into account the latest industry and actuarial approaches, including Lee-Carter, P-Spline, and "cause of death" based models.
- "Superior" if the model is granular and is based on the stochastic behavior of base mortality and mortality improvements. We note, though, that the relative volatility of longevity experience will be a function of the size of the modeled population. Under a "superior" approach, the model may allow for parameter risk and shock improvements, such as a cure for cancer. Under a "superior" approach, the insurer may factor in most alternative modeling approaches and analyze their impact on results.

183. ***Assumptions and parameterization.*** We would likely score an insurer's approach to assumption setting as:

- "Basic" if it uses standard mortality assumptions with only limited tailoring.
- "Good" if it uses a range of approaches to tailor industry tables to its own experience and specific portfolio characteristics. Under a "good" approach, an insurer may take into account recent academic and actuarial research for setting its mortality improvements.
- "Superior" if it analyzes its own experience extensively and analyzes the impact of a wide range of alternative

approaches, particularly with regard to mortality improvements.

184. ***Data quality.*** We would likely score an insurer's approach to data quality as:

- "Basic" if its capital modeling only takes into account the age and sex of policyholders.
- "Good" if it bases its ECM calculations on policy data that incorporates an extensive range of risk factors, particularly items that capture health and socio-economic characteristics of policyholders, including zip codes of residence and occupation, when available. Under a "good" approach, an insurer may use extensive and relevant past data to derive its assumptions. Under a "good" approach, an insurer may use robust procedures to clean data from "walking dead," (annuitants who have died whose deaths have yet to be reported).
- "Superior" when the insurer demonstrates how well it captures the health and socio-economic characteristics of its policyholders.

185. ***Process and execution.*** We would likely score an insurer's approach to process and execution as:

- "Basic" if it models longevity separately.
- "Good" if it incorporates longevity risk in its ECM, reflecting dependencies with other risks, particularly mortality.
- "Superior" if the insurer allows for more complex dependencies (including for instance catastrophe events and financial risks).

186. ***Testing and validation.*** We would likely score an insurer's approach to testing and validation as:

- "Basic" if the validation's main focus is the comparison with standard industry assumptions.
- "Good" if it performs what we consider to be extensive sensitivity and scenario testing on alternative modeling approaches. Under a "good" approach, an insurer may compare its results and underlying assumptions with those of its peers and with the latest applicable academic and industry research.
- "Superior" if it performs what in our view is a particularly extensive analysis of results.

Morbidity risk

187. Morbidity risk generally arises in insurance products that cover losses stemming from accident, sickness, or disability, including:

- Disability income (group and individual);
- Medical care/hospitalization (group and individual);
- Long-term care and Medicare supplement policies (in the U.S.); and
- Specialty products, such as cancer or critical illness policies.

188. Coverage generally takes the form of separate policies or riders to other products, such as life insurance.

189. While mortality or longevity losses are triggered by a single decrement (mortality or lack thereof), morbidity risk is subject to two factors, incidence and severity. Furthermore, morbidity can be affected by subjective claims, such as mental and nervous or soft tissue claims that can be difficult to disprove. Morbidity may also hinge on economic trends. Also, benefit design can influence policyholder behavior. Most health coverage policies are subject to

nonscheduled premium increases that influence lapse and loss experience subsequent to the premium action. Inflation also is a significant consideration in total morbidity experience, unless the benefits paid are set under the contract terms.

190. ***Methodology.*** In our experience, morbidity risk also lends itself to different modeling approaches. We note that many insurers model group coverage using a loss-ratio approach, applying ratios to projected premium levels. In our view, this resembles a P/C approach. Insurers frequently model individual morbidity risk using a more granular approach combining age, sex, and duration, similar to practices in individual life insurance.

191. The pattern of claim payments for morbidity coverage differs considerably from that of life insurance coverage. Depending on coverage, a single loss can result in payments for months or years, and, in the case of disability, over 30 or more years.

192. Therefore, insurers generally project claim payments separately for claims existing at the valuation date and for claims assumed to be incurred in the future. Patterns of future payments on existing claims are frequently estimated based on the period since the original loss date and completion factors (continuance factors for disability insurance), which vary not only by product (disability versus medical, for instance) but also within product categories, such as for elimination periods for disability insurance. In our view, the methodology an insurer chooses should be consistent with the product and should account for the product's key characteristics.

193. Because morbidity-related losses are frequently ongoing in nature and may last many months or years, many insurers frequently analyze loss adjustment expenses (LAEs) along with claim costs. Insurers account for LAEs in their methodology either as part of their expense assumptions or as integrated into their morbidity assumptions.

194. We would likely score an insurer's approach to morbidity risk as:

- "Basic" if it uses simple loss and expense ratios for all coverage, both group and individual.
- "Good" if it models individual products using product specific loss and expense ratios, summary data, or industry data. Under a "good" approach, an insurer may consider management discretion with respect to policy rate increases. Reinsurance is considered at a high level.
- "Superior" if, in addition to the characteristics mentioned above for a "good" approach, the insurer's products use credible insurer experience and granular claim costs (where appropriate), taking into consideration product characteristics and insurer demographics. Under a "superior" approach, an insurer's health modules in actuarial projection systems may be used, where appropriate, rather than spreadsheets. Under a "superior" approach, an insurer's material reinsurance treaties may be reflected consistently with their terms.

195. ***Assumptions and parameterization.*** We would likely score an insurer's approach to assumption setting as:

- "Basic" if the insurer's assumptions are product specific but do not analyze all material benefit structures and geographic and demographic differences including basic claim cost assumptions for individual medical coverage that do not vary by age or geographic region.
- "Good" if it takes into account what we view as material structural, geographic, payment patterns, and demographic differences. Under a "good" approach, the insurer may base its assumptions on industry data

supported by actual insurer data.

- "Superior" if an insurer considers the material structural, geographic, payment pattern, and demographic differences to account for age, sex, coverage, and duration (where appropriate), as well as inflation for medical care costs. Under a "superior" approach, the insurer may use assumptions based on credible relevant insurer experience. Under a "superior" approach, the insurer may take into consideration interdependencies such as economic trends, claims patterns, and rate increases.

196. ***Data quality.*** We would likely score an insurer's approach to data quality as:

- "Basic" when it takes into account source information at only a general level, such as loss ratios for medical products.
- "Good" as its base data increase in granularity, such as by product structure, age, and duration, and as the insurer's own data become more credible, for instance through including more exposure years.
- "Superior" when the base data are sufficiently granular so as to be analyzed by all risk factors and there is a credible volume of data.

197. ***Testing and validation.*** We would likely score an insurer's approach to validation and testing as:

- "Basic" if it conducts minimum testing and validation for its morbidity model, such as back-testing against actual claim counts and amounts or employing "as-if" testing with past extreme events or high morbidity losses.
- "Good" if it includes a wider range of testing on its morbidity risk model results, such as back-testing, scenario testing (including extreme scenarios), potential changes in reinsurance costs, and claim completion patterns, as appropriate.
- "Superior" if it employs a wide range of testing and validation (e.g., sensitivities to assumptions, a multiple real-world scenario-based comparison including extreme scenarios, back-testing, and consistency of sensitivity tests with past experience) to support the appropriateness of its assumptions.

198. ***Process and execution.*** We would likely score an insurer's approach to process and execution of the morbidity model as:

- "Basic" if the insurer runs the morbidity model separately from other parts of the ECM and aggregates the results while ensuring adequate capture of material dependencies. Under the "basic" approach, in some jurisdictions (particularly with respect to group health coverage written in conjunction with mortality risk, meaning group life and health packages), the model may allow for the effect of possible cross subsidies between mortality and health risks on future cash flows.
- "Good" if the model is integrated into the ECM and captures the most important interdependencies with other risks.
- "Superior" if the model is integrated into the ECM, captures all material interdependencies, has a fully documented process of execution, and has fewer manual operations than a "good" or "basic" model.

Lapse risk

199. In Standard & Poor's opinion, different types of policies are subject to risks of surrender, lapsation, or expiry for different reasons. The considerations below apply to all types of non-mortality terminations.

200. Life policies are exposed to the risks of policyholders withdrawing their cash values, not paying, or modifying premium payments in a way that differs from assumptions. Annuities and disability insurance policies may have surrender values as well. At the time of surrender of a policy, the insurer will incur loss or profit depending on the difference between the surrender value and the assets backing the liabilities. An insurer could also incur losses when a policy lapses (and therefore no surrender value is paid) at early durations until the initial expenses have been recouped (in effect, the policy's asset share is negative). The risk of loss at surrender is greatest for contracts with in-the-money guarantees on surrender and contracts with large initial strain because these result in negative asset shares during early durations of the policies. The risk of loss at surrender is also high in situations where there are no surrender penalties. In addition, insurers may lose economic value as a result of the loss of future profits expected until the policy matures or expires. Partly offsetting this in our view is the potential release of capital of the surrendered and lapsed policies. We note that excess surrender experience may also cause liquidity issues.

201. In our opinion, the main challenge for insurers in assessing lapse risk is appropriate assumptions setting. In our experience, lapse experience varies considerably by product, distribution channel, and policyholder profile. Lapse levels may be influenced by a wide range of external factors (e.g., investment performance, regulatory changes, tax changes, the economy, the level of customer service, and insurer creditworthiness). Even though policyholders may not always behave rationally, historical data suggest a link between lapse rates and market performance for products with significant cash values, especially for products with valuable guarantees on surrender. However, in practice it has been challenging for insurers to model that link robustly and to adequately calibrate such models since actual experience may not be a credible indicator of future performance. Standard & Poor's observes that assumption setting may be particularly difficult for new types of products, particularly those with new features, for which relevant past experience may not be available.

202. ***Methodology.*** We would likely score an insurer's approach to its lapse model as:

- "Basic" if the model shows lapses based on best-estimate assumptions "per product" and "per policy year," while capturing the variability of lapses around best estimates through sensitivity and a limited number of stress scenarios. Under the "basic" approach, insurers may choose stresses so that the worst of higher- or lower-than-expected lapses are tested.
- "Good" if the insurer models best-estimate lapses with a higher granularity than per product and per policy year–for instance by distribution network--and uses a stochastic model with some extreme scenario analysis to capture the relationship between competitor rates and policyholder behavior.
- "Superior" if the insurer models all sources of variability stochastically, including dependence on market conditions for business lines where there is strong evidence for links between lapse levels and market performance.

203. ***Assumptions and parameterization.*** We would likely score an insurer's approach to assumption setting as:

- "Basic" if it bases best-estimate lapse assumptions on analyses of lapse experience per product and per policy year and years to maturity or expiry.

- "Good" when the insurer's assumptions consider additional variables such as distribution channel and funding level (for universal life policies) although extreme lapse levels might be based on a significant level of judgment. Under a "good" approach, the insurer may make adjustments in assumptions to account for known changes in experience due to changes in tax and regulations. Under a "good" approach, when setting assumptions for extreme lapses, the insurer may take into account industry wide experience, including, for example, lapse experience of distressed insurers.
- "Superior" when it links lapse assumptions to market performance, while robustly calibrating operational and credit risks.

204. ***Data quality.*** In Standard & Poor's experience, data quality on lapse risk depends on data granularity and the integrity of the systems used to collect them.

205. We would likely score an insurer's approach to data quality as:

- "Basic" when only limited past lapse data with little granularity is available.
- "Good" when there is more extensive and detailed past lapse data. Under a "good" approach, an insurer may use external and industry-wide data, where such data exist, to support its assumptions.
- "Superior" if an insurer validates data against records and makes adjustments for events it perceives as nonrecurring.

206. ***Testing and validation.*** We would likely score an insurer's approach to validation and testing as:

- "Basic" when it conducts minimum testing and validation, such as back testing or as-if testing with past extreme events.
- "Good" when it, in addition to the above, compares assumptions for consistency with the experience of similar existing products and reconciles the results.
- "Superior" when it includes a range of testing on model results, such as back-testing and scenario testing (including past-events testing and testing against the model's worst outcome).

207. ***Process and execution.*** We would likely score an insurer's approach to process and execution as:

- "Basic" when it models lapse risk separately.
- "Good" when it incorporates lapse risk into the ECM and reflects dependencies with other risks, in particular market, expense, and operational risks.
- "Superior" when it allows for more complex market dependencies.

Expense risk

208. Standard & Poor's observes that for modeling purposes, insurers classify expenses in broad categories including investment management costs, administration expenses, overhead or costs incurred at holding entities level, acquisition expenses and commissions, and claims handling expenses.

209. Unit cost assumptions are generally linked to a combination of an insurer's number of contracts, funds under management, premiums, volumes, and the nature of its administrative operations (e.g., lapse, death, premium

collection, and claims payment). The challenge an insurer confronts in modeling future expenses is to derive future assumptions from its past data and expense structure while adjusting its assumptions for structural changes and applying the relevant future cost inflation to unit costs. Standard & Poor's notes that modeling dependencies between costs and other risks can also be challenging for an insurer as stress on its activity can lead it to incur additional costs that past data may not capture.

210. Standard & Poor's notes that cost modeling may be subject to significant judgment and adjustments, particularly in modeling economies of scale or changes in administrative procedures, where the insurer may assume future modifications in its unit costs due to changing volumes over time. It may also rely on the robustness of the insurer's internal cost allocation practices and analytical accounting systems. For example, costs that are classified as acquisition-related instead of administration-related may lead to understating the expenses from the in-force book of business and consequently affecting capital needs.

211. ***Methodology.*** We would likely score an insurer's approach to expense risk modeling as:

- "Basic" when the insurer analyzes future administrative and management costs with an allowance for unit cost inflation and cost volume increases. Under a "basic" approach, an insurer may allocate overhead or other non-policy related expenses (head-office and holding-level costs) to the different businesses, or otherwise allocate them to the entity that generated them. Under a "basic" approach, the insurer's expense modeling may be consistent with the model's general framework. In other words, if new business is modeled, it stands to reason that related future acquisition expenses should be considered for inclusion as well. Under a "basic" approach, an insurer's expense levels may be consistent with relevant indicators such as the number of contracts, premiums, and assets under management. Under a "basic" approach, an insurer may estimate expense deviations based on stress scenarios to include the incremental costs incurred in extreme situations.
- "Good" when the insurer includes more granular modeling of extreme events by identifying the sources of cost increases including those costs not reflected in past data and modeling them through dependencies with the other risks valued in the model.
- "Superior" when the insurer includes modeling expense types separately so as to capture future expense evolution and deviations, depending on relevant volume indicators. Under a "superior" approach, the insurer may allow for costs not reflected in past data but which the insurer could face in extreme scenarios.

212. ***Assumptions and parameterization.*** An insurer typically bases its assumptions on its most up-to-date cost structure consistent with its financial statements. In Standard & Poor's experience, non-accounting assumptions that insurers consider relate to inflation, economies of scale modeling, and potential changes in the cost structure, split between acquisitions and administration.

213. We would likely score an insurer's approach to assumption setting as:

- "Basic" when its inflation assumptions are consistent with other economic assumptions used in the model. Under a "basic" approach, an insurer's other assumptions are aligned with its strategic planning and stress expense assumptions. Under a "basic" approach, an insurer may also explicitly include expense overruns (expenses not anticipated in pricing) and other nonrecurring costs.
- "Good" when it includes more granularity in its inflation assumptions (depending on the nature of its expenses) and bases its assumptions on its own experience and cost structure.

- "Superior" when the insurer analyzes alternative approaches to inflation assumptions and includes other approaches to modeling economies of scale. Under a "superior" approach, a model may include management actions, such as charge increases or cost reduction initiatives.

214. ***Data quality.*** In our experience, an insurer's cost modeling relies primarily on its own analytical accounting data.

215. The main differentiating factors between different levels of scoring of an insurer's approach to data quality are, in our experience, the level of granularity, the period of time over which historical data have been collected, and the extent to which an insurer achieves consistency across historical data.

216. We would likely score an insurer's approach to data quality as:

- "Basic" when it employs broad accounting categories such as administration, claims handling, investment management, or overheads.
- "Good" when it models costs based on its nature, for instance modeling IT and wage costs separately.
- "Superior" when it relies on a historic view of its incurred costs and uses relevant inflation data assumptions according to different expense types.

217. ***Testing and validation.*** We would likely score an insurer's approach to validation and testing as:

- "Basic" when the insurer's model includes a reconciliation of modeled expenses to financial statements, and documents differences between modeled figures and accounting figures. Under a "basic" approach, an insurer may also test baseline figures against its business plan.
- "Good" when the insurer's model includes a wider range of stress tests including extreme scenarios, including testing the reasonableness of unit cost increases.
- "Superior" when the insurer's model includes a reconciliation of extreme cost outcomes with its continuity plan cost budgets. Under a "superior" approach, such testing may also include testing by specific expense type.

218. ***Process and execution.*** We would likely score an insurer's approach to process and execution as:

- "Basic" when the insurer's model analyzes best-estimate cost provisions with limited sensitivity analysis.
- "Good" when, owing to the dependencies between expenses and other risks, the insurer's model captures material dependencies.
- "Superior" when the insurer's model identifies and models the insurer's full set of dependencies and other relevant risks.

Underwriting risk

219. In Standard & Poor's experience, underwriting risk--the risk that the premiums charged for current business along with the premium income from future business may be insufficient to cover losses experienced and expenses incurred from those exposures--is particularly relevant for non-life insurers. Two related risks, reserving and catastrophe risk, are addressed in the next sections of this article.

220. To model underwriting risk scenarios, Standard & Poor's is of the view that the insurer's ECM may anticipate future underwriting activity (e.g., business, product, or geographic mix, and underwriting cycle or premium and

pricing trends) across the insurer's business lines. Under a given set of assumed future exposures, insurers can then model future retained losses using a variety of stochastic loss-forecasting techniques.

221. In Standard & Poor's opinion, there are the two main sources of uncertainty surrounding underwriting risk:

- Business to be written, including volume and assumed exposures, composition and mix, premiums generated, and retained versus ceded risks.
- Future losses, including deviations from expected levels and retained versus ceded risks.

222. ***Methodology.*** Standard & Poor's has observed that when modeling underwriting risk, insurers account for a number of variables such as changes in pricing trends and strategies, product, business, and geographic mix, and use of reinsurance. However, in our experience, considering these variables requires substantial product and line-of-business detail and granularity.

223. We would likely score an insurer's approach to modeling underwriting risk as:

- "Basic" when, in our view, it employs simplified methodologies. Over the years, Standard & Poor's has noted that because of data or technological limitations, some insurers have adopted what we consider to be simplified methodologies in forecasting future underwriting results. For example, an insurer could build the underwriting projections from its historically observed loss ratios, instead of separately forecasting premiums and losses. Consequently, in the absence of detailed projections for future exposure, premium trends, and frequency/severity loss probability distributions, the resulting ECM may not properly integrate emerging changes in underwritten risks, the phases of the underwriting cycle, and the insurer's evolving pricing philosophy. To compensate for the lack of granular projections, such underwriting risk models may intentionally overstate volatility and risk aggregations contagions, going significantly beyond actual experience. The resulting assessment of capital needs would then likely be also overstated. However, this overstatement may serve as a conservative assessment, and may suffice for capital-adequacy evaluation purposes.

- "Good" when methodological simplifications do not in our view weaken the model's functionality. For example, a relatively immaterial or a highly predictable line of business could be modeled simplistically, as long as the rest of the portfolio is modeled in sufficient detail. Moreover, sometimes simplifications may be necessary to overcome data or computer processing-power limitations provided the overall ECM results are not materially affected, and the key sources of risk and uncertainty are properly addressed. Under a "good" approach, the insurer may provide assumptions regarding future exposure and premiums, although losses should in our view be modeled in sufficient detail. These assumptions of future exposure may encompass expected or planned changes to the business mix and may be consistent with the insurer's business plan. Under a "good" approach, the insurer may quantify risks arising from variations from the business plan through stress testing. Under a "good" approach, the insurer may split risks into homogeneous groups for all significant classes of business and integrate known and emerging trends affecting the frequency and severity of losses into loss trends. These could include litigation, climate, terrorism activity, and the regulatory environment. Under a "good" approach, the insurer may model claims in sufficient detail to reflect accurately underlying volatility and to enable the application of any risk mitigation approaches. Under a "good" approach the implementation of the underwriting risk model may consider the dependencies between (i) small and large losses (if separated for modeling purposes); (ii) future cash flows and loss reserves via stochastic paid- and incurred-loss development patterns; (iii) macroeconomic trends, such as inflation, claim costs trends, and foreign exchange, and general economic activity (which affects the volume of insured interest); (iv) reinsurance counterparty risk and overall credit risk analysis; and (v) contagions

stemming from extreme events. Strong ERM practices pay special attention to emerging risks in our view. To the extent that an insurer's ERM identifies and evaluates these risks, we note that insurers have historically accounted for them explicitly within its loss forecasts. Robust allowance for potential new types of claims in the capital model would likely be a component of a "good" score.

- "Superior" when the insurer applies methodologies sufficiently sophisticated for a realistic assessment of capital needs, and that would also enable other decision-making functionalities (e.g., optimizing pricing strategies, product, business, and geographic mix, and reinsurance purchases). Under a "superior" approach, such methodologies may include the features of a "good" module and incorporate a pricing module interdependently forecasting trends across main classes of business and geographies. Under a "superior" approach, scenarios for the underwriting cycle and pricing movements may be developed stochastically, may be based on in-depth underwriting cycle analyses, and may encapsulate management's and the industry's view of future trends. Under each pricing scenario, the model may assume the amount of business written in each segment with future business volumes maintaining their dependency on pricing levels. Stochastic ultimate-loss models may reflect these future-business and exposure projections. The loss forecast may also attempt to compensate for "unknowns," such as extreme/large-loss patterns, e.g. via Extreme Value Theory and/or external data sources; the uncertainty in parameter selection; and emerging risks.

224. In our experience, insurers often present forecasts especially for large losses, via loss frequency and severity, and obtain the aggregate-loss (net and gross of risk transfer) probability distribution by convolution. Frequency/severity forecasts in our experience provide flexibility in analyzing risk-transfer alternatives (particularly for non proportional reinsurance), and make it possible to address the counterparty (reinsurance) risk. However, if implemented within the ECM, we understand that frequency/severity models may significantly slow calculations. Therefore, although we are of the opinion that future losses should be modeled within the ECM, we understand that insurers routinely perform certain calculations outside the ECM.

225. ***Data quality.*** Businesses change over time as do exposures that insurers assume. Loss and policy data from a few years ago may in our opinion lose relevance for future loss projections. We note that insurers who have opened new lines of business may have difficulty determining relevant data for their underwriting projections. In the absence of good-quality loss-history data, underwriters and actuaries may look for a relevant proxy from an external source. Often, in our experience, they must rely on their expert opinion to develop loss scenarios and convert them to empirical probability distributions.

226. We would likely score an insurer's approach to data quality as:

- "Basic" when it collects and maintains historical loss and policy data, including data from the acquired and divested businesses. We would expect loss valuations to be updated at least quarterly.
- "Good" when in addition to the above it includes development scenarios for large losses, for instance, minimum, expected, and maximum ultimate-loss scenarios.
- "Superior" when its claims and policy database captures relevant details, including regular loss-valuation updates enabling paid- and incurred-loss development analyses; alternative development scenarios, including worst-case scenarios, for the largest open claims; the ability to retrieve and reconcile data in different formats, including individual-loss listings, loss counts, and aggregate losses by homogeneous lines of business; a database coded to reflect coverage terms, including retentions, cover limits, and currencies; and premium-volume and exposure data that could be mapped to loss-data groupings. If an insurer's own data are not sufficient, external data sources

may be used to supplement internal data, including external benchmarks or proxies to help compensate for insufficient data, particularly catastrophic-loss data; and published expert analyses of insurance market cycles, claim-cost trends, exposure inflation, and other historical patterns, along with emerging trends. Under a "superior" approach, the insurer may validate data used to populate and set parameters for its ECM by checking for reasonableness and reconciled to actuarial studies and financial statements.

227. ***Assumptions and parameterization.*** Insurers derive model parameters from assumption-adjusted loss and exposure data. In our view, there is inherent uncertainty in the selection of these assumptions and parameters.

228. We would likely score an insurer's approach to assumptions and parameterization as:

- "Basic" when it employs certain assumptions and parameters while not taking into account any uncertainties regarding their selection. Under a "basic" approach, assumptions may be timely, and may integrate current conditions, views, opinions, and anticipated trends, be supported by research or expert opinion and be consistent with assumptions applied elsewhere in the ECM.
- "Good" when it employs a reasonably conservative set of assumptions and parameters that would be more likely to overstate than understate the insurer's risk and capital needs.
- "Superior" when its calibration and population of its underwriting risk model focuses on uncertainties arising from assumption and parameter selection. An insurer could present some assumptions as random variables, if values are highly uncertain and their variance significantly affects model results. Under a "superior" approach, parameters may be based on an estimation method that captures extreme outcomes and the most critical assumptions and parameters may be supplemented by alternative parameter sets (see testing and validation below).

229. ***Process and execution.*** Paragraph 67 provides an overview of general process, execution, and governance principles that we would consider as applicable to modeling of underwriting risk.

230. ***Testing and validation.*** In Standard & Poor's experience, many underwriters use quantitative tools to support pricing decisions and would likely note major inconsistencies in outputs through an ECM's underwriting risk module.

231. We would likely score an insurer's approach to testing and validation as:

- "Basic" when it reasonably reconciles model outputs with historical loss experience, underwriting/pricing estimates, and financial/business plans. A "basic" approach may also show consistency between the model outputs and the ultimate liability projections derived from loss reserve models.
- "Good" if it includes alternative assumptions and parameters, testing their impact on overall ECM results (for instance, their effects on solvency and profitability indicators).
- "Superior" when it uses sensitivity analysis to identify selected methodologies and parameters that could materially affect the outcome of the ECM and then attempts to reduce model risk by further refining the model's calibration (e.g., by benchmarking against an external data source), building uncertainty stemming from parameter selection into the model, and presenting "what if" model runs based on alternative sets of assumptions. Under a "superior" approach insurers would seek expert opinions to validate the reasonableness of particularly severe underwriting-loss and event-contagion scenarios that models may generate.

Reserving risk

232. Insurers recognize and report outstanding liabilities under insurance contracts in the form of loss reserves. A loss reserve is an estimate of funds needed to be held in order to meet all claims arising from policies currently in force and those written in the past. The ultimate amount of these future payments is usually unknown and can be highly uncertain. This is particularly true for liability risks underwritten on a "loss occurring" basis. At the same time, even claims-made classes of business, such as D&O (directors and officers), can have highly uncertain ultimate costs, particularly when they depend on the outcome of a law suit.

233. A loss reserve represents these future costs' best estimate, but as such, it may underestimate the insurer's liabilities. Reserve risk modeling aims to quantify this potential shortfall. Models are used to project the ultimate amounts to be paid, but may also forecast period-to-period movements in loss reserves.

234. Standard & Poor's notes that to help assess capital erosion scenarios within the ECM, the insurer's reserving risk model could be designed to capture underlying volatilities and modeling-process uncertainties, or model risk. Reserving risk in our view also could account for risk diversification and aggregation within and across insurance business lines, as well as between insurance and other risk categories, such as credit, market, and operational risks. With enough product and class-of-business detail and granularity, this model can support other decision-making applications, such as analyses of pricing strategies; performance by product or business, and geographic mix; reinsurance effectiveness.

235. ***Methodology.*** Modeling approaches may vary for different business classes and would often depend on data availability.

236. A number of methodologies may be used to recreate, as stochastic processes, the period-to-period development of incurred and paid losses. These methodologies rely on solid loss-development data and tend to apply to risk classes with large numbers of claims and a relative consistency in the assumed risk, including business lines with stable policy terms, retentions, limits, and underwriting characteristics of insured risks. For example, U.S. workers' compensation is among risk classes that tend to lend themselves to such modeling methodologies.

237. We note, however, that a clear development pattern is often statistically unobtainable from cumulative aggregate-loss history, for instance in low frequency and high severity risks, and especially when litigation is involved. We have observed that in evaluating the total amount payable under a large claim or a batch of claims, an insurer has to rely on expert opinion and estimate the impact under the given coverage terms. Based on observed internal and external tendencies, claims assessors and other internal experts can evaluate various outcomes, their likelihood, and possible interdependencies. These projections may then be aggregated, for example within a combined random-sampling or Monte-Carlo simulation model.

238. Data limitations may prompt an insurer to adopt a simplified methodology. For example, an insurer could assume that all large notified claims will reach the limits, particularly when the covered limits are relatively low. Although simplistic, such loss reserve projections could still be useful, particularly in evaluating, albeit roughly, an insurer's capital adequacy but some precision and decision-making functionality is lost.

239. We would likely score an insurer's approach to modeling reserving risk as:

- "Basic" if the insurer's reserving risk model adopts one of these simplistic methodologies with a conservative bias.
- "Good" when methodological simplifications do not in our view weaken the model's functionality. For example,

a relatively immaterial or highly predictable line of business could be modeled simplistically, as long as the rest of the insurer's liabilities are modeled in sufficient detail and so long as the ECM results are not materially affected. Under a "good" approach, insurers may analyze several methodologies (such as Over-Dispersed Poisson (ODP), Mack's Model, and Bootstrapping). Under a "good" approach, the extreme outcomes that the selected approach generates would likely be consistent with loss-development scenarios for known large claims and the base case scenario and expected values would likely be consistent with actual reserves and with ultimate-loss forecasts (size and variability).

- "Superior" when the model is in our view sufficiently detailed and sophisticated to assess the insurer's targeted capital while also enabling other decision-making functionality (e.g., evaluating pricing strategies, product, business, and geographic mix, and reinsurance purchases). Under a "superior" approach, such methodologies may be based on stochastic modeling of reserves and based on an insurer's own relevant loss-development history, split by homogeneous business lines. Under a "superior" approach, an insurer may use external data to obtain a broader view of potential outcomes. Under a "superior" approach, the methodology may reflect observed and emerging regulatory, socio-economic, and claim-cost trends, and capture key interdependencies, such as reserving risk across main business lines, links with macroeconomic scenarios, and counterparty (reinsurance) risk, among others.

240. Standard & Poor's has observed that strong ERM practices pay special attention to emerging risks, particularly latent risks in insurance contracts. Robust allowance for potential new types of claims and latent claims in the ECM may be factors in our decision to score an insurer's methodology as "good" or "superior."

241. Because risk reserving models often rely on scarce data, insurers may derive value from sensitivity testing of selected parameters and assumptions. Insurers may also further refine key parameters and assumptions and/or build uncertainty arising from parameter selection into the risk reserving model.

242. ***Data quality.*** Businesses change over time as do exposures that are assumed by insurers. Loss and policy data from a few years ago may lose relevance for future loss projections. Insurers that have opened new lines of business may have difficulty determining relevant data for their underwriting projections. In the absence of good-quality loss-history data, underwriters may look for a relevant proxy from an external source. Often, they have to rely on their expert opinion to develop loss scenarios and convert them to empirical probability distributions.

243. We would likely score an insurer's approach to data quality as:

- "Basic" when the insurer collects and maintains historical loss and policy data, including data from the acquired and divested businesses, it updates loss valuations at least quarterly. All data used to populate and parameterize an ECM model would be checked for reasonableness and reconciled to actuarial studies and financial statements.

- "Good" when in addition to the above it includes development scenarios for large losses, for instance, minimum, expected, and maximum ultimate-loss scenarios.

- "Superior" when its claims and policy database captures relevant details, including regular loss-valuation updates, occurring at least quarterly, enabling paid- and incurred-loss development analyses; exposure details, and any changes, such as geography, limits, retentions, and other coverage terms; and assessment of alternative development scenarios (including worst-case scenarios) for the largest open claims. Insurers may also collect relevant external data, including external benchmarks or proxies, if available, to help gauge period-to-period loss-development volatility; published expert analyses of claim-cost trends, regulatory changes, and other

developments, along with emerging trends; and multiple, alternative sources of data and industry views.

244. ***Assumptions and parameterization.*** Standard & Poor's notes that in modeling loss-reserving risks insurers use assumptions to analyze historical data and formulate future scenarios. Insurers derive model parameters from assumption-adjusted loss and exposure data. In our view, there is inherent uncertainty in the selection of these assumptions and parameters.

245. We would likely score an insurer's approach to assumptions and parameterization as:

- "Basic" when it employs certain assumptions and parameters while not taking into account any uncertainties regarding their selection. Under a "basic" approach, assumptions may be timely, and may integrate current conditions, views, opinions, and anticipated trends, be supported by research or expert opinion and be consistent with assumptions applied elsewhere in the ECM.
- "Good" when it employs a reasonably conservative set of assumptions and parameters that would be more likely to overstate than understate the insurer's risk. Under a "good" approach, parameters may be based on an estimation method that captures extreme outcomes and the most critical assumptions and parameters may be supplemented by and compared with alternative parameter sets (see testing and validation below).
- "Superior" when the calibration and population of an underwriting risk model focuses on uncertainties arising from assumption and parameter selection. An insurer could present some assumptions as random variables, if values are highly uncertain and their variance significantly affects model results. Under a "superior" approach, parameters may be based on an estimation method that captures extreme outcomes and the most critical assumptions and parameters may be supplemented by and compared to alternative parameter sets (see testing and validation below).

246. ***Process, execution, and governance.*** Paragraph 67 of this article provides an overview of general process, execution, and governance principles that we will apply to the modeling of reserving risk.

247. ***Testing and validation.*** In Standard & Poor's experience, many actuaries use quantitative tools to support pricing decisions and would likely note major inconsistencies in outputs through an ECM's reserving risk module.

248. We would likely score an insurer's approach to testing and validation as:

- "Basic" when it reconciles model outputs with historical loss experience, underwriting/pricing estimates, and financial/business plans. A "basic" approach may also show consistency between the model outputs and the ultimate liability projections derived from loss reserve models.
- "Good" if it includes alternative assumptions and parameters, testing their impact on overall ECM results (for instance, their effects on solvency and profitability indicators). Under a "good" approach insurers may also seek expert opinions to validate the reasonableness of particularly severe reserving loss and event-contagion scenarios that models may generate.
- "Superior" when the insurer uses sensitivity analysis to identify selected methodologies and parameters that could materially affect the outcome of the ECM and then attempts to reduce model risk by further refining the model's calibration (e.g., by benchmarking against an external data source), building in uncertainty stemming from parameter selection into the model, and presenting "what if" model runs based on alternative sets of assumptions. Under a "superior" approach, insurers may also seek expert opinions to validate the reasonableness of

particularly severe reserving loss and event-contagion scenarios that models may generate.

Catastrophe risk

249. Standard & Poor's observes that life and health insurers typically forecast catastrophe losses by analyzing their specific risks. For example, catastrophe life insurance losses such as those that might occur as a result of an avian flu epidemic would be viewed as a sub-risk under mortality risk. Insurers typically handle catastrophe considerations for P/C coverage in a separate analysis. For this reason, we address P/C catastrophe risk separately.

250. Insurance has long been used to absorb losses from catastrophe events and their consequences, including windstorms, earthquakes, floods, terrorism, and pandemics. Among affected coverage areas are personal and commercial property, business interruption, workers' compensation, automobile physical damage, third-party, and product liability.

251. Unless explicitly excluded, catastrophe risks have traditionally been an integral part of the overall underwriting risk of an insurer. Therefore, all criteria listed in the underwriting risk modeling section of this article apply to catastrophe risks as well. In addition, though, we have developed expanded criteria for catastrophe risk modeling because of its significance for many insurers and to recognize the material analytical advancements made in this field in recent years.

252. ***Methodology.*** Some insurers build their own proprietary catastrophe risk models, particularly when they possess enough data to credibly forecast losses on their exposures. Please refer to the underwriting risk modeling section for criteria applying to these models.

253. We would likely score an insurer's approach to catastrophe risk modeling as:

- "Basic" when the insurer relies on a single third-party modeling vendor since this limits the number of views of possible claim patterns to those of a single party.
- "Good" when the insurer employs more than one model.
- "Superior" when the insurer uses outputs from more than one catastrophe-modeling vendor, along with more customized, in-house-developed models. Standard & Poor's notes that insurer-specific catastrophe scenarios may not be fully captured by industrial software. Under a "superior" approach, the insurer may confirm differences in the modeling assumptions and approaches from standard third-party models. Under a "superior" approach, these models may analyze and test "rippling effects," such as demand surge, while also taking into account integrated scenarios, such as a catastrophe combined with insolvency of a reinsurer, or the simultaneous occurrence of natural and man-made catastrophes. Under a "superior" approach, an insurer would likely model the implications of the underwriting cycle, such as potential hardening of the market.

254. ***Data quality.*** For how Standard & Poor's would likely assess an insurer's approach to data quality, please refer to the underwriting risk modeling section. In addition, for catastrophe risks, insurers should, in our opinion, pay special attention to exposure data. In evaluating catastrophe risk, we would look to see that projected exposure data are detailed and up-to-date.

255. ***Assumptions and parameterization; testing and validation, and process and execution.*** We would apply the criteria outlined in the underwriting risk modeling section.

Appendix 4: Operational Risk

256. In Standard & Poor's experience, insurers often implement operational risk models by capturing loss frequency and loss severity in an integrated manner. Operational risk loss data that insurers collect internally are often sparse, and those collected external to the insurers are, in our view, difficult to apply due to issues around the applicability, scalability, and completeness of the losses. Therefore, insurers often supplement their internal and external historic loss data with scenario loss data as more fully described below.

257. There is no universally accepted definition for operational risk in the financial services industry. Insurance groups with banking subsidiaries are likely to have adopted most of the Basel II definition (see "International Convergence of Capital Measurement and Capital Standards – A Revised Framework, Basel Committee on Banking Supervision, June 2006) of operational risk, which includes the risk of loss resulting from inadequate or failed internal processes, people, and systems, or from external events, and includes legal risk but excludes strategic risks. The main exception would be reputation risk, which can be a significant consideration for insurers, especially due to the increasing emphasis on branding. In our opinion, a robust enterprise-wide ECM needs to cover all material risks. If an insurer's definition of operational risk excludes material risks such as reputation risks, we would then seek to ascertain that the insurer models and assesses these risks as a risk type other than operational. However, we would apply our operational risk model criteria when assessing these risks.

258. In addition, we note that because of the nature of operational risk and the various practices that insurers commonly implement, we will take into account in our analysis an insurer's assumptions, granularity, and the validation process, when evaluating whether we would qualify a given methodology as "basic," "good" or "superior."

Methodology

259. We would likely score an insurer's approach to operational risk modeling as:

- "Basic" for an insurer that adopts a "factor-based" approach. Such insurers would thus assess their capital as a percentage of a relevant risk indicator, such as total capital or premiums written.
- "Good" if an insurer models operational risk loss frequency and loss severity or operational risk yearly losses using a stochastic framework, while considering loss mitigants (for example, through insurance written by an unrelated insurer).
- "Superior" if an insurer stochastically models loss frequency, loss severity, and effectiveness of controls, analyzes appropriate loss mitigants, and allows for model or basis risk to account for possible inaccuracies of the modeling approach for major risks. Under a "superior" approach, the insurer may analyze not only the direct financial impacts that may arise when an operational risk materializes, but also the reputation and strategic impacts and consequently any additional resulting costs that may be incurred. Insurers could address these various impacts through analysis that fully maps causes to effects so as to capture all potential interactions.

Assumptions and parameterization

260. We would likely score an insurer's approach to assumption setting as:

- "Basic" when an insurer demonstrates the calibration of operational loss severity data fitted to a log-normal distribution, with little if any challenge to such assumptions. In addition, insurers may use loss frequency data to estimate probability of single events. The results could then be used to calibrate a factor-based approach where

applicable.

- "Good" for insurers that calibrate severity to a fat-tailed distribution, while calibrating frequency to a distribution that allows multiple events.
- "Superior" when an insurer assesses the quality of its internal controls for each major loss event, in addition to the calibration described above under a "good" approach.

Data quality

261. We would likely score an insurer's approach to data quality as:

- "Basic" if it uses only industry data.
- "Good" if an insurer conducts internal workshops to identify operational risk loss frequency and severity, and maintains an internal database of loss history.
- "Superior" if it collects historic internal loss data and "sense checks" them through internal experts, while taking its loss data from a number of cross-referenced sources to ensure consistency. These sources may include external loss databases containing industry losses, as well as internally collected losses, information regarding internal assessment of quality and effectiveness of internal controls, and evidence of internal workshops identifying the impact and likelihood of events.

Process and execution

262. We would likely score an insurer's approach to process and execution as:

- "Basic" when an insurer models operational risk as a stand-alone risk, represented by a percentage of other risk capital.
- "Good" when an insurer meets the standards for a "basic" score, while encompassing testing of scenarios including operational risk events.
- "Superior" when an insurer models operational risk events with other risks during the main stochastic run, addressing scenarios including the testing of operational risk events.

263. In addition, we note that because of the nature of operational risk and the various practices that insurers commonly implement, we will analyze the assumptions, granularity, and validation process when evaluating whether a given methodology would qualify as "basic," "good" or "superior."

Testing and validation

264. We would likely score an insurer's approach to testing and validation as:

- "Basic" when it does not validate its results.
- "Good" when it compares its operational risk capital with industry losses and standards (for instance percentage of premiums).
- "Superior" when it compares its operational risk capital with industry losses, in turn compared with senior management's assessment of risks, and when it uses these comparisons to assess operational risk capital against scenarios of possible events.

RELATED CRITERIA AND RESEARCH

- Evaluating The Enterprise Risk Management Practices Of Insurance Companies, May 17, 2005
- Refining The Focus Of Insurer Enterprise Risk Management Criteria, June 2, 2006
- Strategic Risk Management: The Upside of ERM, July 26, 2006
- Economic Capital Review Process For Insurers, Feb. 5, 2007
- Principles Of Corporate And Government Ratings, June 26, 2007
- Economic Capital Review Process For Insurers: Criteria Update, Sept. 6, 2007
- Methodology: Assessing Insurers' Economic Capital Models, May 15, 2008
- Application Guide: Assessing Insurers' Economic Capital Models, May 15, 2008
- Analysis Of Insurer Capital Adequacy, Dec. 18, 2009
- Assessing Management's Commitment to and Execution of Enterprise Risk Management Processes, Dec. 17, 2009
- Expanded Definition Of Adequate Classification In Enterprise Risk Management Scores, Jan. 28, 2010
- Refined Methodology For Assessing An Insurer's Risk Appetite, March 30, 2010

265. These criteria represent the specific application of fundamental principles that define credit risk and ratings opinions. Their use is determined by issuer- or issue-specific attributes as well as Standard & Poor's Ratings Services' assessment of the credit and, if applicable, structural risks for a given issuer or issue rating. Methodology and assumptions may change from time to time as a result of market and economic conditions, issuer- or issue-specific factors, or new empirical evidence that would affect our credit judgment.